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# THESIS

## AN ANALYSIS OF THE COMPUTER SYSTEM CHARGEBACK CONCEPT IN THE NAVAL INDUSTRIAL FUND ENVIRONMENT

by

Terry D. Schechinger
Arthur E. Prack III

June, 1983

Thesis Advisor: Carl R. Jones

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# An Analysis of the Computer System Chargeback Concept in the Naval Industrial Fund Environment

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June 1983

# ABSTRACT

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# I. INTRODUCTION

## A. PURPOSE

On February 7, 1978, the General Accounting Office (GAO) delivered a report to the Congress entitled "Accounting for Automatic Data Processing Costs Needs Improvement." After studying the cost accounting practices of 26 Federal organizations, the GAO concluded that all of them were using accounting methods that were inadequate in some ways. The report stated that without accurate costs, computer center managers may choose uneconomical alternatives when replacing or adding to computer facilities, and may fail to appropriately charge users of computer facilities for services performed. Further, functional managers cannot make the best decisions when they are not aware of the total cost of implementing and operating their applications systems. The report concluded that the current mission funded concept was not adequate for the cost accounting necessary for computer operations [Ref. 1]. To help alleviate this problem, and in response to a congressional study conducted by the House Appropriations Committee's (HAC) Survey and Investigation Staff, the Navy recommended the addition of the Navy Regional Data Automation Center's (NARDACs) to the Navy Industrial Fund (NIF) as part of the FY 1984 Navy input to the President's budget.

This thesis is designed to provide an initial analysis of this recent decision. It will require that NARDACs bill customers for all data processing services and necessitates the development and implementation of a computer chargeback system whereby the NARDACs will be reimbursed by users for the cost of DP services provided.

As with all new decisions there are many unresolved issues. The potential consequences of this decision and such issues as which chargeback approach is most appropriate for a NARDAC to employ, as well as the greater issues of costs, benefits, goals and objectives of computer system chargeback will be addressed in order to evaluate the potential usefulness of the system; to provide an insight into potential pitfalls; and as background information with which to discover methods to minimize disruptions generated by the chargeback introduction.

## B. BACKGROUND

The decision to impose a chargeback system, whereby a previously "free" good or service is converted into one for which users are to be charged, is a controversial one which fundamentally alters the relationship between the user and the provider of DP services. That organization which was formerly a collegue and a provider of free services now becomes a supplier that makes demands on scarce resources in return for services rendered. The success of this conversion will be affected by a whole host of factors such as the organization's policies, goals, political structure, internal and external environment, maturity, and structure. In fact, the major economic and utilization issues thought to drive the issue may only be peripherally responsible for its imposition. A further factor complicating this conversion process is created by the very nature of the computer resource.

As Dearden and Nolan point out [Ref. 2], the computer resource differs from other staff activities in three ways:

1. The resource has a simple purpose - economy. That is, the computer resource exists solely to help operating units and staff offices execute their

responsibilities better through cheaper processing of data, more efficient organization of information systems, and procurement and deployment of information that is too expensive to obtain otherwise.

2. The resource has a complex set of supply/demand characteristics.
   - a) The supply side displays the following characteristics:
     - i) The ratio of fixed to variable cost is high. That is hardware and systems development costs are high, but variable operating costs are low. Consequently, EDP managers tend to maintain a constant, full capacity workload on a computer system, since the cost of incremental work is so very low. Figuring out which new demands should replace existing demands is very difficult and leads to priority problems.

       Supply side

     - ii) Incremental capacity must be acquired in relatively large blocks and cannot be smoothly augmented to accomodate a linear demand growth. For example, the acquisition of a large central processor may double capacity.
     - iii) It is assumed that computer hardware offers economies of scale. This point will be elaborated upon later in the thesis when the economic implementation of pricing computer services is discussed. As will be seen, an expansion in capacity may result in a less-than-proportional increase in costs. However, if the computer is not used to full capacity, and total costs are fully

allocated to the users, the users may find themselves paying more to process their jobs than before.

b) The demand side has the following characteristics:
   - i) Needs for EDP services grow rapidly in complexity and sheer size.
   - ii) Processing tends to be cyclical.
   - iii) One computer system is usually unable to serve all diverse demands that a large organization can place on it.
   - iv) Processing priorities are highly variable depending on the application, the users, and the timing.

demand pred

3. The computer is still relatively new and its use is rapidly growing with the resultant investment decision and staffing uncertainties.

Largely as a result of the uniqueness of the computer resource, the user and the provider will discover that there are as many "appropriate" techniques and philosophical approaches as there are parties affected by the chargeback implementation decision; many approaches are legitimatized only by enlightened self-interest. Even if those affected undertake a study of the available techniques and underlying philosophies thereof, they will find no common "best" chargeback method. Rather they will discover that there is a significant amount of material written on the subject, some of which is practical and some purely theoretical.

Some of the reasons for the lack of a uniform, practical approach to computer chargeback is due to the unique nature of the computer resource and due to the methodological and philosophical bias that is heavily reflective of the writer's chosen academic or professional discipline. These biases can preclude viewing the problem from a total system

perspective and can result in a failure to take into consideration the political/organizational realities that face the rank-and-file manager. A further problem is the shortage of empirical evidence or research conducted to support the hypothesis proposed as fact.

In some cases, that which is driving the chargeback decision is part of a larger organizational problem. For example, poor DP center cost control, excessive demand for services of questionable value, or insufficient control of capacity may have proliferated in an uncontrolled fashion because of a lack of budgetary and management control of the information resource. Thus, a first step may be to identify an Information Systems Manager who may be expected to improve cost control and computing capacity by rather simple, albeit politically-charged, organizational changes.

Another complication may be that there is little common agreement within the organization on the percieved goals the chargeback system is to realize. Some members of the organization may see it as a method to improve resource allocation; others may view improved cost control as the primary goal; some members may view chargeback as a method to improve the efficiency of the DP department; and others may view it more parochially as a means to free up more capacity for their own interests or applications; and finally some members may view chargeback as a mechanism to contol the proliferation of only marginally useful requests for DP services, reports, and applications. In reality these are all different ways of looking at the same problem. That is, they all relate to the problem of efficient resource allocation.

In short, conversion from a "free" good environment to a chargeback environment is a difficult and politically charged process replete with undetected landmines waiting for the unsuspecting. The selection of a "best method" will

be only peripherally aided by a detailed literary search since varied organizational perceptions of chargeback goals and objectives can be expected.

## C. HISTORICAL PERSPECTIVE

The proper initial selection and implementation of a chargeback technique and its related resource rates are of pivotal importance if a given NARDAC is to provide quality service, at a fixed annual rate, in such a manner that it "breaks even". This is not, however, a position unique to governmental organizations and a short review of the history of the computer chargeback design helps keep this recent decision in proper perspective.

In the early 1960's many large corporations adopted the policy of not charging for the cost of the computer, fearing that doing so would discourage computer use. Instead the cost of the computer was absorbed as overhead. The next several years were characterized by a rapid growth in computer applications and by increased budgets for hardware, software, and DP personnel. Then corporate policy changed and chargeback became the mechanism to control this growth and distribute the cost of the computer [Ref. 3].

Prior to the advent of multiprogramming, allocating costs was quite simple. Logs were kept by hand, and costs were shared by dividing the total cost by the number of hours used, as measured by a wall clock, and each user was charged for a prorated share. However, with the advent of multiprogramming (which provided the means to use previously wasted CPU cycles that were lost when a system awaited the completion of an I/O operation) the process became more difficult. The DP manager was faced with the need to distribute the cost of his installation among multiple and simultaenous users and this sharing of resources was a

problem in developing a chargeback system. Usage records could no longer be maintained by manual time recording. More sophisticated methods involving the computer's monitoring and recording its own use were needed and were developed. Today, a comprehensive and accurate way to measure use of a large group of system resources (e.g. CPU time, disk and tape I/O counts, and print lines) exist for most mainframes and operating systems [Ref. 4].

In the early 1970's chargeback systems became more detailed and precise with the DP departments attempting to account for every microsecond of resource used. Often this resulted in systems which were unsatisfactory and failed to provide the user and management with a usable and understandable cost and billing system. Although, theoretically, these systems resulted in the recovery of DP costs, they often failed to provide meaningful cost and budgeting data required by the users and management. Indeed, some companies have taken this process one step farther and are demanding that their processing centers generate a profit instead of merely recovering operating costs [Ref. 5].

There is little doubt that the prevailing trend is to charge for computer services. The next obvious question is whether the system is accomplishing the desired organizational objectives. Influencing of behavior cannot be avoided, whether the computer is treated as a "free good", whether charging is for cost recovery, or whether it is for resource allocation. Each of these pricing philosophies results in a different pattern of user behavior [Ref. 6]. The key question is does the pattern of behavior anticipated/realized reflect what the organization desired and does the chargeback technique foster the attainment of organizational objectives?

## II. THE CONTROL SYSTEM AND CHARGEBACK

The control system can be viewed as the set of processes through which organizations ensure that actual activities conform to planned activities. It can be viewed as consisting of: (1) the establishment of standards and measures; (2) the measurement of performance; (3) the comparison of performance against standards; and (4) the taking of corrective action [Ref. 7].

The control system is the critical network which integrates and coordinates an activity with the rest of the organization's operations. It accomplishes this objective via a tailored mix of control subsystems. These subsystems include: the strategic and tactical planning subsystem (a multiyear view) which attempts to assimilate technologies and systems to match the organization's evolving needs and strategies; the project management subsystem which consists of the methodology selected to control, coordinate, and guide the lifecycle of individual projects (which often last more than one year); and the management control subsystem which focuses on guiding an activity on a year-to-year basis. This latter subsystem can be visualized as consisting of the control architecture, the financial control process, non-financial controls and auditing (see section A below).

In a computer facility, control procedures are usually accomplished via such mechanisms as chargeback accounting and overhead accounting, plans and audits, funding and development proposals, and project management. The actual mix and implementation of these techniques is tailored by the organization to ensure that its needs are met both effectively and efficiently. Thus, another critical aspect

of the control system is its dynamic nature. As organizational objectives change over time, so must the control system which is tailored to coordinate the organization's actions to meet these objectives. That is, the control system design and implementation for a computer facility must be expected to evolve over time. This control system design demands that several fundamental questions be answered, i.e., How much money and time should be spent on the control system? How should the resources be deployed for maximum effectiveness? Are resources being employed efficiently? [Ref. 8]

Several authors have indicated that controlling the computer resource is significantly different than the better understood problems of control in other areas of organization operations. As previously mentioned, Dearden and Nolan [Ref. 9] contend that controlling the computer resource differs as a result of its single purpose economic orientation, its complex set of supply and demand characteristics, and its relative newness which complicates investment decisions and causes staffing uncertainties. Cash et. al., [Ref. 10] contend that the control system must be adapted to a very different software and operations technology in the 1980's than was present in the 1970's as a result of such concepts as consideration of software maintenance as capital investments, the complexities of measuring and allocating costs so as to encourage appropriate behavior, and as a result of the cost behavior of computer technology over time. Cash et. al., also point out that the control system must encourage appropriate appraisal of the potential costs and benefits of new uses of the computer resource by the user and must strike an optimum balance between the conflicting requirements of innovation and control. Innovation involves risk-taking, gaining trial experience with emerging technologies, relying on faith, and at times

moving forward despite a lack of clear objectives. Control on the other hand depends on measuring costs against budgets, actual versus promised achievements, and evaluation of investments against return.

## A. MANAGEMENT SUBSYSTEM CONTROL: ONE VIEW

As mentioned above, the key factors constituting the management control subsystem can be visualized as consisting of the Financial Control Architecture, the Financial Control Process, Nonfinancial Controls, and the Auditing Function.

The Financial Control Architecture can be determined by answering such questions as: Is the center to operate as an unallocated cost center, an allocated cost center, a profit center, or an investment center? Further, if costs are to be allocated, should the transfer price be market based, cost based, cost plus, split level, or negotiated? Each of these alternatives generates quite different behavior and motivation and are fundamental decisions which, once made, are not lightly changed. These alternatives are discussed at length in sections J through L of this chapter.

The Financial and Nonfinancial Control Process is concerned with action plans, budgets, periodic reporting instruments, exception reports, and the like [Ref. 11].

The Auditing Function is the examination of information by a third party, other than the preparer or the user, with the intent of establishing its reliability, and the reporting of the results of this examination, with the expectation of increasing the usefulness of the information to the user [Ref. 12].

These items will not be discussed in any detail at this time since much of this material is discussed at length in later sections of the thesis. The important point is that the control system is a complex web of interleaved

structures with no perfect system in existence. Each control system is tailored to meet the specific needs of the organization and later discussions of strengths and weaknesses of particular concepts can only be made with the assumption that a certain mix of control subsystems has been chosen by the organization.

## B. BUDGETING AND THE CONTROL SYSTEM

One part of the control system that is of pivotal importance is the budgeting process. Within the Department of Defense the budgeting process is a very rigorous and well-defined process. It is in the budgeting process where the master plan for the organization is developed. A budget is, in fact, a formal quantitative expression of management plans. The master budget summarizes the goals of all phases of the organization. From a NARDAC perspective, it can be thought of as the instrument by which they depict targets for sales, production, net income, and cash position, and for any other objective that management specifies. In private industry, the master budget often consists of a statement of expected future income, a balance sheet, a statement of cash receipts and dispursements, and supporting schedules (See Fig. 2.1).

From a control system perspective, the major benefits of budgeting are: First, budgeting compels management to think ahead by formalizing their planning responsibilities. Second, budgeting provides definite expectations that are the best framework for judging subsequent performance. Third, budgeting aids managers to coordinate their efforts, so that the objectives of the organization as a whole harmonize with the objectives of its parts [Ref. 13].

1. Master Budget.
    a. Operating Budget.
        (1) Sales Budget.
        (2) Production Budget.
            (a) Materials used/purchased.
            (b) Direct labor.
            (c) Indirect Overhead.
        (3) Cost-of-goods sold budget
        (4) Selling expense budget.
        (5) Administrative expense budget.
    b. Financial Budget.
        (1) Cash budget: cash receipts and disbursements.
        (2) Budgeted balance sheet.
        (3) Budgeted statement of income and applications of funds (net working capital).
2. Special budget reports.
    a. Performance reports (comparisons of results with plans).
    b. Capital budgets (long range expectations for specific projects).

Figure 2.1 Master Budget.

Thus, the budgeting process can be viewed as the foundation of the management control process with a major objective of allocating scarce resources. While the planning effort sets the broad framework for the data processing activity, the budgeting process ensures that fine-tuning in relation to staffing, hardware, and resource levels takes

place. A second important objective of budgeting is to set a dialogue in motion to ensure that organizational consensus is reached on the specific goals and possible short term achievements of the activity. Finally, the budgeting process establishes a framework around which an early warning system for negative deviations can be built. Without a budget, it is difficult to spot deviations in a deteriorating cost situation in time to take appropriate corrective action [Ref. 14].

## C. NARDAC: THE CONTROL SYSTEM AND MOTIVATION

Within the NARDAC/NIF/Chargeback context, three key elements of the control system equation exist: the NIF accounting system; the chargeback technique which is fundamental to the NIF cycle of operations; and the budgeting process. An equally important, but more subtle consideration, is the motivational impact on management which is created by the real or perceived performance measures that are fostered by these three systems, specifically, and the control system in general. Decisions regarding such fundamental concepts as cost recovery orientation versus profit center orientation, charging or not charging for systems and programming efforts, partial cost recovery versus complete cost recovery, etc., should be made within the context of the defined control structure and the corresponding measures of performance by which management will be judged.

Fundamentally, the control system should be designed to provide standards, budgets, and the fixing of responsiblity as key factors in the control system, interleaved in such a fashion that the desired motivational impact is attained. Motivation is, in fact, the overriding consideration in formulating and using measures of performance. Above all else, the systems and techniques used in the control system

should encourage management to act in harmony with the overall objectives of the organization. Often these objectives are far from well-defined. Thus, as an initial first step, in designing a control system, top management must ensure that its goals are well-defined and specific, and that the measures of performance are geared to measure and reflect these objectives.

## D. CONTROL: AN ACCOUNTING PERSPECTIVE

From an accounting perspective, the directing of attention, the providing of clues, the raising of pertinent issues, and the inducing of desired behavior are principal planning and controlling tasks. According to Horngren [Ref. 15], the system should answer such basic questions as:

1. What are the objectives of the organization as a whole?
2. Who is expected to seek such objectives? What are their spheres of responsibility?
3. What data can be provided to help them make individual decisions that will harmonize with, and spur them toward, over-all organization goals?

As was previously mentioned, the precise determination and communication of an organization's goals is a required first step. The second question can be partially answered via some form of responsiblity accounting system. The greater problem is how to answer question three, i.e., how does the system ensure harmony of objectives and define its judgemental performance measures, especially in the stabilized rate context of the NIF funding environment? As will be discussed in Chapter IV, the NIF process of rate stabilization sends very poor signals to high level management and conceivably undermines the basic premise of the responsibility accounting system.

Horngren proposes six questions which, when answered, may provide an indication of possible motivational weaknesses of the accounting portion of the control system.

1. Does the measurement system overemphasize one facet of operations? Here the greatest danger is overemphasis of one measure of performance. This could be overemphasizing rate of return on assets as a measure of efficiency. An organization would probably be better served if it used a variety of performance measures such as: (1) return on investment; (2) share of the market; (3) efficiency or productivity; (4) innovation; (5) employee attitudes; (6) public responsibility; (7) personnel development; and (8) balance between short and long-range goals. The relative weights of these performance measures is a high level management decision which must be explicitly defined if the organization is to pursue organizational objectives in the manner desired by management.
2. Does the measurement system encourage short-run gains to the detriment of long-run results? For example, attempting to compensate for a short-run cash flow problem by shortening the billing cycle may not be in the best interest of the organization as a whole.
3. Does the measurement system fail to delineate responsibility? Here responsibility accounting should be extended as far down in the organization as possible.
4. Does the measurement system fail to distinguish between controllable and uncontrollable costs? The important point here is that for performance measurement purposes, controllable and uncontrollable items should not be mixed together.
5. Does the system encourage false record keeping? Perhaps the source documents are too complicated or

perhaps there is excessive pressure which causes subordinates to record time erroneously or tinker with usage reports.

6. Does the system engender full cost analysis? That is, does the system properly indicate cause-and-effect relationships which help management from making erroneous decisions regarding either evaluation of performance or selection among courses of action?

Thus, given that the three vital elements of a control system are standards, budgets, and the ability to fix responsibility, any management accounting system, to be effective, must be designed around the responsibility centers of individual managers.

## E. CONTROL SYSTEM AND THE COMPUTER RESOURCE

Dearden and Nolan contend that a control system for a computer installation needs to be tailored for its own particular needs - a system which ensures that its needs are met both effectively and efficiently. They contend that management control of the computer resource should be much easier than the control of other staff activities since the goal of the computer resource is a single, straightforward economic one, in contrast to multiple, partially noneconomic goals for other staff activities. However, this simplicity in goal setting is more than offset by the complexity of the supply/demand characteristics of the computer resource and the uncertainties in both planning and execution that inhere in this area. They further state that no other staff activity exhibits the constellation of supply/demand characteristics and other special circumstances. The complexity of this constellation makes it necessary to provide some central planning for procurement and deployment of the resources.

Dearden and Nolan also contend that there is no single answer to the question of how management can best exercise control over the computer resource, but that certain conclusions can be drawn from the studies they have conducted. These include:

1. Systems currently in use differ widely in the degree of centralization that is exercised;
2. No single system will be successful for all organizations;
3. The successful control system will change for any one organization over time. In fact, they contend that the successful control system will move from complete centralization to nearly complete decentralization;
4. The type of system a company uses will be less important in determining successful control than the way in which it is administered.

Centralization, as they use it, refers to the degree of chargeback employed, i.e., No Chargeback, Partial Chargeback, and Complete Chargeback. Ideally, they feel, the full chargeback system is the control system toward which most organizations should work. For the present, until organizations gain experience in controlling the computer resource, they believe that most organizations would be well advised to adopt partial chargeback systems fitted to their particular stages of computer development.

## F. FRAMEWORK FOR DESIGN OF A CONTROL SYSTEM

Adopting the Dearden and Nolan framework for design, four levels of analysis are needed. First, the organization must generate guidelines on how much to spend on computing, what systems to develop, and how it will judge efficiency and effectiveness. Second, the control system itself significantly affects the EDP operation on all fronts. Hence, the

organization should assess the way in which its control system functions to evaluate, motivate, and communicate among the various groups involved. Figure 2.2 outlines the elements of the analysis. Note that the main monitoring points are inputs, processing and outputs. The main control points are processing and inputs (since outputs can be altered only by altering inputs and processing). Third, once a decision is made on how much to commit to computing - in finances and in personnel - both efficiency and effectiveness must be monitored and controlled. As Figure 2.2 shows, both should be heavily monitored and controlled in the process component. Project management is the primary control mechanism in this component. Finally, the major topic that an organization should debate about the output component is this: How should the EDP group alter the services provided - through new applications or the modification of existing ones - to continue to be effective. The analysis of output, which necessarily will be a historical analysis, will help top management see what actions should be taken to control the input and process components.

The questions listed in Figure 2.2 should be useful in making this analysis.

## G. CONTROL SYSTEM PROBLEMS

Now that there is a framework with which to discuss the control system, there are a number of potential difficulties which may complicate the process of implementing a selected control system during the NARDAC transition to the NIF funding environment.

First, it should be recognized that the NIF (Navy Industrial Fund) activity's customer is participating in the preparation of an appropriation budget (which will contain a request for monies to eventually pay the NIF

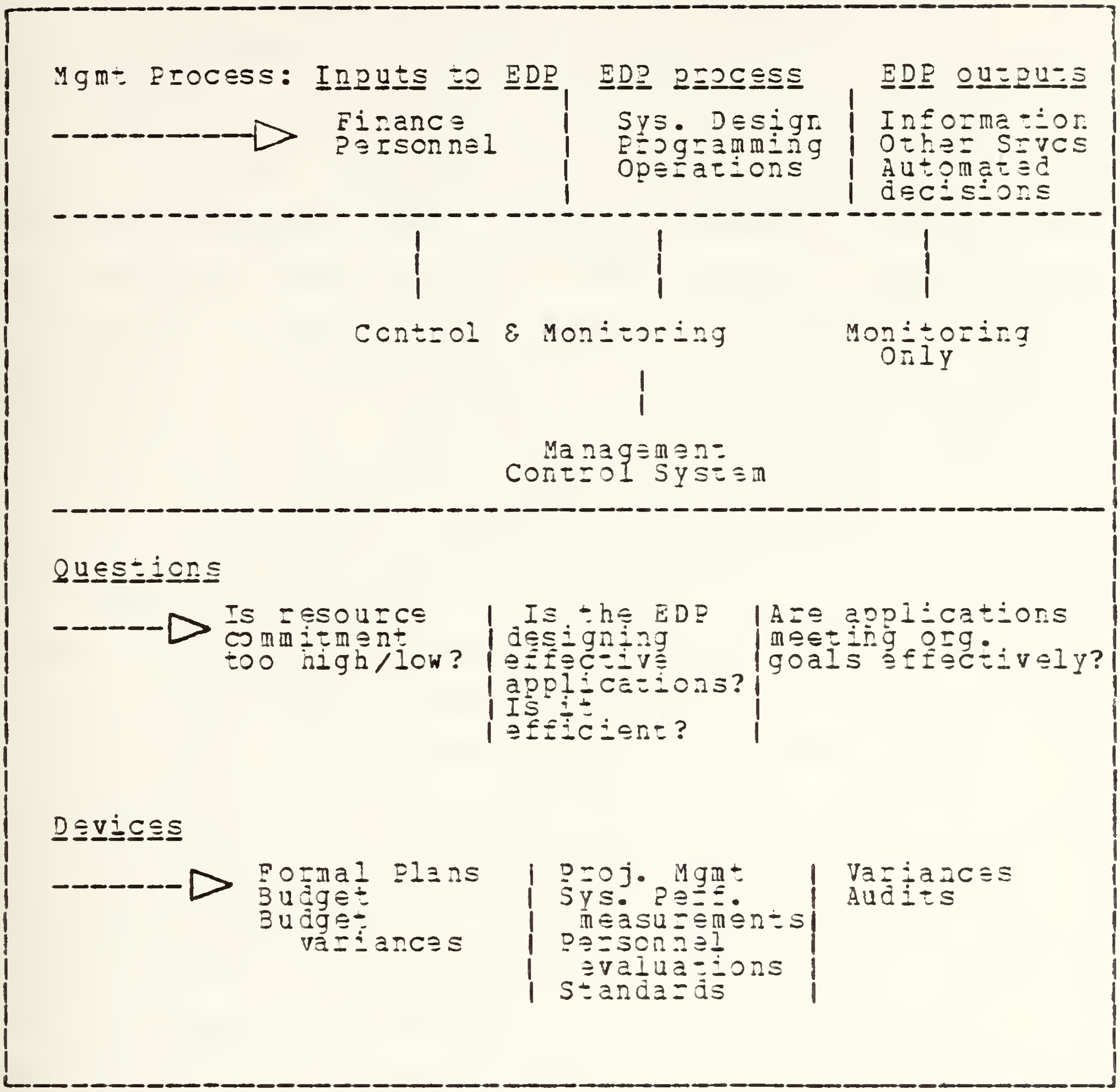

Figure 2.2 Control Systems Design.

activity for its products or services) at the same time the NIF activity and its parent command are preparing a NIF budget (which contains the anticipated work to be performed for customers) for the same period for each NIF activity group. Consequently, the work load estimates upon which the activity NIF budget inputs are based, are predicated on the customer's initial submission of the related appropriation

budget. In subsequent reviews, work load and related dollars and ceilings may be increased or decreased. The two budgets, appropriation and NIF, are reconciled in the review process.

The very obvious weak link in this process is that in order for major claimants to prepare and submit Program Objective Memoranda (POM) issues necessary to fund present and future ADP requirements, there needs to exist a method to reliably accomplish ADP planning estimation. With the shortage (or non-existence) of historical data, and the undetermined price structure, the methodology for costing existing and/or new work will be in an embryonic stage, and will be potentially unreliable and inaccurate. Current procedures call for the NARDACs to aid customers in costing out new ADP requirements or those requiring a change in scope, in dollars and people to do the job. It appears that these will be only approximations with arbitrary cost escalation factors incorporated for the out year rates, especially since out year stabilized rates have yet to be determined and actual rates will require arbitrary predictions of actual resources used for that job. Further, the process of projecting the costs of new work and/or enhancements oriented to the development effort does not satisfy the requirement for a method of predicting or providing cost estimates in the production mode. From a NARDAC perspective, accurate budget inputs are only possible if new work cost projections (development and production) use the same procedure as is used to generate customer's bills. Although it is very difficult to construct a cost simulation model due to the large number of variables which can influence the outcome of a customer's bill, e.g., volume of input/output, processing frequency, etc., accurate and consistent cost estimation requires such a capability. This ability to provide accurate and reliable cost estimates is the cornerstone of the entire budgeting process.

A second potential budget problem area will be the natural tendency for all concerned parties to be overly conservative in their budget estimations due to the lack of historical data and the previously discussed difficulties in cost estimation. From a NARDAC's perspective this could result in unnecessary gains at the expense of the customer's funds. Obviously, excessive optimism in budgeting is equally destructive since this would result in adverse impacts on the cash position of the activity as work is completed and billed to customers at less than actual costs. Normally, this excessive budgeting optimism or pessimism is corrected via the NIF budgetary review process. However, without an accurate method to project costs neither NAVDAC, NAVCOMPT (Comptroller of the Navy) nor OSD/OMB (Office of the Secretary of Defense/ Office of Management and Budget) will be able to accurately accomplish their reasonableness review of the NAVDAC/NARDAC budget submitted.

Another major problem which can reduce the effectiveness of the budgeting process is the adverse effect of NIF required rate stabilization (See Chapter IV). This requirement eliminates a large measure of managerial flexibility at the NARDAC level, and drastically reduces the ability of the NARDAC Commander to control the financial position of his command. Under rate stabilization, the number and kinds of rates to be used is set by an Activity Group Manager (NAVDAC in the case of NARDACs) based on the activity's organizational structure, diversity of workload, and other management considerations. These rates, once set, are to remain in effect for the duration of the fiscal year. While this system does ease the budgeting problem of the users, it greatly complicates the budgetary problems for the NARDAC Commander, especially in the uncertain near term NIF conversion environment. It further sends some very poor signals to the NARDAC Commander about where the real power to control

financial decision making resides. Certainly, it is difficult to hold a Commander accountable for budgetary problems when the billing rates and adjustments are controlled by others. As a further complicating factor, the stabilized rates proposed by NAVDAC (which are not finally determined until completion of the NAVCOMPT and OSD/OMB reviews), are prepared approximately fifteen months prior to its execution. These rates may not be reflective of current costs.

A third control system variable which must be considered in the budget preparation process is the determination of whether to use standard rates or individual NARDAC activity rates. The major concern here is in terms of the responsibility signals that are sent to top management. The use of standard rates will also make it more difficult for an individual NARDAC activity to budget for equipment changes, the dynamic nature of workload requirements, etc., and may not be at all relective of the resources used and costs involved at a particular site. Further, such managerial initiatives as granting discounts to large consumers, and the use of flexible pricing as a technique to smooth the problem of peak demand, are rendered more difficult, if not made impossible.

Finally, there is a whole host of lesser budgetary issues that remain unresolved and complicate definition of the control system. Will valuation of capital assets be via replacement cost, purchase cost, or salvage value? Should software be depreciated? If so, how do we determine its useful life? Are free services provided to a tenant NARDAC to be included in the billing rates? If not, how will performance measurement criteria be compensated for to ensure the generation of accurate and meaningful results throughout NAVDAC? How are the NARDACs to capitalize underutilized or non-utilized plants/facilities/equipment? Will it be treated as a mobilization or wartime reserve? Are

databases a capital asset? If so what is their projected life and how is a database's value determined? How is the cost of the NIF Financial Control System to be funded? Are customers to be charged for expenses not related at all to their jobs, such as Commercial Industrial Activity studies and reports?

It should not be expected that any of these budgetary problems will be eliminated over the near term. The NAVDAC NIF fiscal year 1984 budget was developed based on data available from operations under the O&MN appropriation, and the fiscal year stabilized rates will be developed based on this budget. Similarly, the fiscal year 1985 budget and stabilized rates will be based on work load projections from the NARDACs operation under the O&MN (Operations and Maintenance Navy) appropriation. The fiscal year 1986 budget and stabilized rates will be the first ones developed utilizing actual performance and cost data collected under the NIF environment. Therefore, fiscal year 1986 will be the first opportunity to realistically evaluate the effectiveness of the transition of the NARDACs to NIF.

From a Responsibility Accounting System perspective, the decision to use process cost accounting as opposed to job order cost accounting will complicate the NARDAC's basic relationship with the users. Under process cost accounting, costs are identified to specific products or services in lieu of specific customer orders as is done under job order cost accounting. Under this system, direct costs are all costs which can be directly identified to the process of producing end-products or services for any customers. Conversely, production costs of these types which cannot be identified to the process of producing end-products or services for customers are defined as indirect costs. While this may provide more facility to manage the NARDAC/NAVDAC mission, it precludes the customer from tying his bill to a particular job cost account.

From a motivational perspective, with the return and redistribution to the major claimants of the mission funds budgeted and identified for funding the NARDACs, unless the NARDACs are able to provide an appreciable ADP cost saving to the users, there will be a strong tendency on the part of these users to implement their own ADP service in-house via minicomputers, especially now that they are reasonably inexpensive. Perhaps this is not contrary to what the organization is willing to accept, but a decision of this nature should be a conscious decision and not one made after-the-fact.

Finally, one of the most critical aspects of the control system is the selection and development of meaningful performance standards. It must be remembered that a particular figure does not operate as a norm simply because the Comptroller calls it a standard. It operates as a norm only to the extent that the executives and supervisors, whose activity it measures, accept it as a fair and attainable yardstick of their performance. Generally, operating executives are inclined to accept a standard to the extent that they are satisfied that the data is *accurately recorded*, that the standard level is *reasonably attainable*, and the variables it measures are *controllable* by them [Ref. 16]. Thus, the development of production measurement and productivity standards need to be developed in all areas of operations so that NAVDAC has a scientific way to judge the relative efficiency of all of the NARDACs in a way that is judged accurate, attainable, and controllable by the respective NARDAC Commanders. Further, the productivity measures selected need to permit comparisons between NAVDAC activities and private industry. This will become critical in the out years when the NARDAC's begin operating in a competitive environment. Obviously, this requires the construction of a job order structure which will permit the extraction of

meaningful performance measures. For example, proper management will require that the NAVDAC monitor performance and costs in numerous resource pools or cost centers. Performance or productivity measurements in each resource pool for each NARDAC needs to be extracted and variance analysis between actual and planned performance needs to be accomplished, emphasizing each NARDAC's performance in relation to one another and, most importantly, analyzing trend data by concentrating on relative changes vice absolute values.

## H. CONTROL SYSTEMS: A FRAMEWORK FOR VIEWING THE CHARGEBACK PROCESS

This chapter lays the framework within which the following sections of the thesis needs to be considered. NIF, the Chargeback system, the Budget preparation process, performance measures, etc., do not exist unto themselves, but are part of the greater organizational control structure. There is no right or wrong system, and each organization will tailor a control system to meet its needs and optimize its performance. Specific, chargeback techniques, accounting practices, and performance measures will all have strengths and weaknesses and particular situations where they are most applicable. Thus, advantages or disadvantages of chargeback techniques, for example, must be addressed within the context of the selected control structure. What is important is not necessarily the control structure itself, but how it is implemented. Incorrect control system decisions made early in the NIF transition stages will be hard to recover from in the future.

## I. CHARGEBACK OBJECTIVES

Historically, management has implemented a chargeback system in the belief that it would directly accomplish a host of organizational objectives. These include:

1. improving ADP cost accounting and cost control;
2. increasing ADP efficiency as a result of the cost orientation perspective;
3. increasing customer awareness of ADP costs;
4. causing customers to critically evaluate their ADP requirements based on the economic value of requested services (i.e. to serve as a check and balance against providing unnecessary or unjustified services);
5. recovery of ADP costs;
6. effective allocation of computer resources and the encouragement of load leveling, by adding a factor or granting a discount to a job which requires a high priority or can tolerate a lower than standard priority.

There may also be a number of indirect benefits which may be realized by implementing a chargeback system. For example, it may provide a quantitative basis for equipment evaluation with respect to cost and performance. Further, by allowing each system resource to pay for itself it may make justification of additional hardware simpler or more direct. It may provide derived data which can be used to adjust an installation's operations schedule. It can provide a quantitative basis for project costing. Finally, it may encourage user participation in design decisions as a result of user awareness of the costs of computer resources.

## J. FULL COST RECOVERY OR PROFIT CENTER

The attainment of these objectives is at least partially a function of the chargeback technique selected for implementation. Prior to the selection of a specific technique one of the key issues that must be resolved is whether the computer center is to operate in a full cost recovery or profit center mode.

The essence of this issue is whether the rates charged for computer services should provide only for recovery of costs or for generation of a profit by the computer center. Under the service center approach rates are set with the objective of generating revenue just sufficient to cover the costs of the computer center. Under the profit center approach rates are set to provide an excess of revenues over costs.

The cost recovery approach could result in lower charges for computer services and, therefore, could tend to encourage fuller use of computer resources. This may be especially important to organizations that have just acquired a new system and are trying to promote its use. This approach should stifle any desire by users to patronize outside service bureaus, since the charge for using the internal facility should be less than the amount charged by a service bureau. Also, the use of a cost based charge should tend to reduce the occurrence and intensity of disputes over the equity of charges. Such disputes are especially common when rates based upon market rates are used.

The profit center approach may be a superior means of motivating the management of the computer facility. Not only is there motivation to hold costs down, but also to provide quality services that will maximize the satisfaction of user needs. The computer center manager becomes market

oriented and seeks to develop and provide new services that take advantage of the best available technology for the benefit of the users and the total organization. It also provides a better basis for economic evaluation of the computer facility by top management. Comparison of the return on investment of the computer facility with that of other parts of the organization gives some indication of whether the investment in computer resources is justified relative to alternative uses of organizational funds. If users are willing to pay the rates charged and use most or all of the available capacity, a large profit should be generated to signal the need, as well as to provide justification, for additional investment in computer facilities [Ref. 17].

## K. CHARGING FOR SYSTEMS AND PROGRAMMING

What to charge for?

One of the more controversial aspects of a chargeback technique implementation is how and when to charge for systems and programming activities. This decision will require high level policy resolution since there are equally valid pro and con arguments. For example, charging for development programming services can be a most efficient safeguard against the development of systems that are unnecessary or unwarranted from a business perspective. Further, the mere act of recording costs required for charging will enhance project control. Concurrently, it can be expected that programmer productivity will improve as the incentive to minimize controllable non-productive time is fostered. Finally, it can provide data which will facilitiate comparing the cost of outside services when the need for contracting out arises.

These advantages must be tempered by considering some potential disadvantages. Charging for systems and program development increases overhead, can discourage innovation and creativity, can foster inter-organizational conflict and could result in the loss of control over programming personnel. Users may perceive the programmers as "their people" since the users are paying the bill. They may also feel justified in demanding the best people be placed on their jobs and react strongly to personnel shifts from their pet projects, especially if time is a significant factor [Ref. 18].

## L. CHARGEBACK TECHNIQUES

The degree of realization of chargeback objectives and the methodology used in the selected chargeback algorithm define implicitly the management philosophy regarding the role of ADP in the organization. The two basic chargeback approaches are the cost approach and the pricing approach. The difference in the two is primarily philosophical, i.e., the cost approach motivation is one of recovering the cost of computing services whereas the price approach considers that it is of greater importance to coordinate demand for a resource with its availability and to allocate computing resources in a rational and effective manner [Ref. 19].

There is considerable overlap between the two approaches since it is impossible to completely disassociate price and cost. Fundamentally, the problem is to decide on the resources for which to charge, determine the rates to be used, and having an appropriate system to handle the record keeping regardless of the philosophical approach to be utilized. The following chargeback techniques are the most

popular and have been the most discussed in the chargeback literature.[1]

### 1. DP as an Overhead Function

In this approach the costs of DP are not charged directly to the user departments but are treated as part of corporate overhead, which may or may not be allocated to the various profit centers within the activity. The basis for cost allocation is generally indirect and not based on any measurement or use of services. This is simply an old-fashioned accumulation of cost in a DP budget without any attempt at recovery.

The accumulation of all costs under one cost center is a strong reason for this approach. It tends to keep the EDP department "honest" because it must account for its funds in a straightforward manner and it keeps the responsibility for the EDP department costs where they belong, within the service producing organization. Other advantages of this approach are: simplicity, avoidance of additional accounting costs, encouragement of user computer experimentation, the tendency to insulate DP from the fluctuations in the organization, and to provide the EDP department with a guaranteed annual budget. It further tends to permit equal treatment of all user departments and agencies, and (if the facility is not fully utilized) it obviates the need for a chargeout system because there is enough capacity to accomodate all users.

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[1] The chapter on DP User Chargeback in *DP Processing Management* published by Auerbach Publishers Inc. provides a good breakdown of alternative techniques. These will be discussed and amplified upon to provide as broad a base for analysis as possible.

Unfortunately, there are several serious disadvantages:

1. When processing becomes a free service, it is unlikely that management will allow uncontrolled growth, and informal or intuitive means of control are inevitably adopted (i.e., if resource allocation is not done explicitly it will be done implicitly) [Ref. 20].
2. The only limit in this type of system is the upper limit of the EDP budget [Ref. 21].
3. Users tend to overuse the system, running jobs of even slight value or interest because they are not charged. That is, there is no incentive to make efficient use of the computer since it costs them nothing and a particularly poor job of resource allocation is accomplished [Ref. 22].
4. There is no feedback which permits users to evaluate how efficiently projects have been handled and who is responsible for the projects [Ref. 23].
5. There is no assurance that the actual users of computer services are the ones who need the service the most ("most worthy" is a personal judgement) [Ref. 24].
6. Users are tempted to substitute computer resources for other resources for which they must pay hard budget dollars [Ref. 25].
7. Management has no guide as to when additional capacity is really needed since users would tend to keep the system in a state of perpetual saturation [Ref. 26].
8. Management tends to view computer services as a non-productive overhead instead of a cost-saving device [Ref. 27].

9. Without a chargeback procedure there is a lack of incentive to write efficient programs [Ref. 28].

This method is often used when it is argued that it is difficult to relate specific costs to individual users. It is most widely used in small companies or when a company first begins to use the computer resource. In this method, users will tend to exercise little control over the efficient and effective use of the computer services. With such a chargeback system, centralized control is necessary, possibly via a steering committee designated to identify needed systems; determine systems development priorities; project manpower requirements for systems and programming; and project future hardware and software requirements.

### 2. DP as a Charged Out Cost Center

This approach involves taking some or all of the DP departments incurred expenses and directly charging other departments or operations for them, according to some scheme or formula. The costs thus charged then show up directly in the profit and loss statement of the user department and are generally viewed in the same manner as if they were incurred outside the company or organization. These costs can be allocated to achieve either full or partial recovery. In a full cost recovery approach, the object is to zero out the costs incurred by the DP organization through charges to users. With partial recovery, some portion of the incurred DP expenditure intentionally remains unallocated.

#### a. Full Recovery Approach (Total Cost Recovery)

In a full recovery approach, the object is to zero out the cost of the DP cost center; thus, every dollar of expense must somehow be assigned to DP users. The easiest way to achieve this is to identify the services,

units of work, resources, and other items for which a charge is to be made and treat them as a product line. Cost accounting techniques are applicable in determining the direct and the indirect costs associated with each item. Any cost expected to be incurred in running the operation is included in either the direct or indirect category. Rates or unit charges for each item (e.g., resource or service) are determined by dividing the total cost to be recovered for the resource or service (direct and indirect) by the expected use of that resource or service [Ref. 29]. The basic notion is that all users are charged as closely as possible for actual resource utilization; machine billing is based on actual useage and standard rates, as collected by a computer based system. The overall objective is to match the income and the expenses of the ADP function. Services provided to outsiders may be billed at a higher cost so that charges to inside users can be reduced.

In theory this results in full recovery of costs. In practice this is not the case and one must either accept a non-zero balance condition where the difference is treated as overhead, or force a zero balance condition by an after-the-fact adjustment (either a refund or an extra allocation). A variant of the full cost recovery approach is to operate the computer center not only to recover costs but also to show a profit.

### b. Partial Recovery Approach

Partial recovery is more complicated than full recovery because it is designed to recover only a portion of DP's costs. While there are two primary reasons for adopting this approach, the effect of both is the same: part of the DP costs are not charged back.

One reason an organization might adopt this approach is that it feels a charge should be made only for direct costs; overhead or indirect cost is not intended to be recovered. The second reason for adopting a partial recovery approach is that the organization feels that some services performed by the DP department should be charged, while others should not [Ref. 30]. The decision on which functions to charge out will be closely tied to management philosophy and organizational policy, and the organization's control system.

There are two basic variants to the partial recovery approach. The first variant is the recovery of operating costs only; these include machine and operator time, input costs, stationery, data controls, etc.. System development costs are not allocated to users. The basic reasoning behind this approach is that the investment in the computer is justified only if the computer is fully utilized. Since it costs so much to develop systems and programs before any use can be made of them, the organization as a whole bears such costs in order to encourage users to employ the machine.

The second variant is just the inverse. System development is charged to the user but data center services are provided as a corporate function. This approach recognizes the difficulty of total cost allocation, in that development costs are regarded as truly allocable since they are carried out for a particular user, whereas operating costs are not since they are incurred on behalf of all users of the equipment. The drawbacks to this type of approach are as follows:

1. The efficiency with which the computer is used is less controlled since users do not bear these costs.
2. There is increased difficulty in differentiating between the systems and programming development work

and the maintenance work required to keep systems operational.

3. The development of computer systems may involve a considerable element of "research" work on new hardware and software and, as is common with other research projects, it is often difficult to estimate what the cost of such work will be [Ref. 31].

### 3. Average Costing

Average Costing is an implementation of the Full Cost Recovery Approach. It attempts to spread total costs over a specific time-frame on the assumption that variances in usage, such as peak-hour usage, will tend to average out between users over an extended period of time. This method is based on a cost allocation model that predetermines the cost per unit (in terms of time or performance) of every component of the computer configuration. Every job is billed according to the number of units or the components consumed, where the number of units is multiplied by the charge per unit. Typical billing centers are the CPU, memory, printers, card readers, key-punch machines, disks and tapes. Total costs for a billing center are determined by calculating its direct costs and loading it with indirect costs according to a cost accounting formula. In theory, all users pay their fair share.

This practice does, however, encourage a peak loading problem since the user knows that his costs will not vary significantly, even if all of his jobs are high priority, rush jobs run in the prime shift. Further, computer operations have a high fixed and a low marginal cost for incremental additional utilization. When demand for computer service is low, relative to supply, then average cost pricing leads to high prices. If demand increases, the added costs are low and as a result the

prices drop. The influence on the user's behavior is just the opposite of what might be desired, i.e., it would be preferable to have prices low when demand was low so as to encourage additional use. Additionally, this method could cause bottlenecks with critically scarce resources (e.g. Input/Output Channels) since the penalty for being wasteful is relatively small. Thus, it may be necessary to use priority or rationing devices to augment this system or else charge for demurrage.

It is, however, simple and easily understandable to users and, therefore, less subject to dispute than other chargeback methods. Furthermore, the rates may also be used for project costing and economic feasibility analysis of proposed new applications.

### 4. Wall Clock Time per Job

This method first appeared during the second generation of hardware, particularly in government installations, with "elapsed time" as noted by an operator being multiplied by a fixed machine rate to get the cost to be billed to the user. The charge was never more than an approximation of the actual costs and it is inconsistent in a multiprogramming environment.

### 5. Elapsed Time in Monoprogramming Mode

This is a variation of the wall clock time system. It assumes a given job is the only job being run at the time; an assumption that ignores the inherent operating efficiencies of multiprogramming and, thus, it generates unrealistic cost figures.

### 6. Elapsed Time in Multiprogramming Mode

This method avoids the above problem but it is complex and difficult to measure accuarately, to the extent that many users have rigorously avoided using it. Package systems are available, however, to accomplish this task with reasonable efficiency and at an acceptable level of cost.

### 7. Fixed Fee Charges

Fixed Fee charges are attractive because they give the user precise cost figures in advance. However, the utility of the system depends on how accurately the costs are allocated by the ADP function and, if there are overruns, the excess must be passed on to other users. This approach has several variations such as flat rate (e.g. an hourly rate) where the rate is determined by dividing total expenses by the total number of hours that the resource is used, or flat-rate-by-shift where the off-peak hours have lower prices and thus the demand peaks are leveled off to a degree.

### 8. Flexible Pricing Method

This method attempts to use an internal mechanism to achieve an efficient allocation of computer services as well as cover costs. Billing of customers is varied automatically, so that a high charge will be billed when the quantity demanded is high relative to the production capacity, and a low charge is billed when the quantity demanded is low relative to production capacity. This approach is designed to equate demand and supply at the highest possible prices.

### 9. Incremental Cost Method

In this approach each user specifies his requirements for computer services; these requirements are converted to specific configurations; costs of the final configuration are allocated to the users; users evaluate the costs allocated to them against expected benefits and consequently change their demand. This practice is iterative in nature.

### 10. Market Prices

The majority of organizations that price computing services on the basis of prices of like services on the open market do so because the computer center is structured as a profit center. Market oriented pricing techniques include current market price, market price less a discount, negotiated price, and average market price. When the information can be acquired, the current market price is the internal price used by many firms. The underlying management philosophy is that decentralized management should operate within the framework of an open competitive market. This is thought to allow valid evaluation of computing center performance [Ref. 32].

Market prices provide a more stable charging rate and better motivation of the data processing manager, but also have significant disadvantages. For example, market prices may not be readily available and a considerable amount of time and effort is required to determine the appropriate current market price; the problem of handling peak demands and high turnaround for priority work are unresolved; and the economics of computing may not be the only reason for having an internal computer - speed, security, privacy of data, and flexibility may also be considered very important. Finally, there is also the greater question of whether users should be able to use outside services at all.

## M. CHARGEBACK SYSTEM STANDARDS

There are certain universal standards which are applicable to all chargeback techniques and which must be present for a successful program to be realized. The purpose of the system must always be kept in mind when considering a selected chargeback technique for the presence of these standards. The amount of time, effort, and cost invested in the system should be balanced by the size of the organization and the contribution of chargeback to the control system. These standards include:

1. Equitable - all charges, including personnel, equipment, and overhead costs, should be based on use data gathered by the system, with each customer billed only for the quantity and cost of resources used. As a corollary to this standard, one group of users or one user must not be subsidized at the expense of another. To do so would open the chargeback system to accurate charges of being unrealistic and unfair.
2. Reproducable (Repeatable) - The cost of a job must not be contingent on the system load, i.e., it should cost the same to run job "A" on a completely empty sytem as it would if job "A" was running with numerous other jobs. The cost of a job run today under a set pricing policy should be the cost of the same job tomorrow under the same pricing scheme. A variance of no greater than one per cent is thought to be acceptable. Similarly, if a given application is run more than once, the system should generate comparable charges, regardless of when the job is run or the job mix. (If the user has specified a turnaround time, this standard need not apply.)
3. Realistic - This standard is satisfied by deriving charges from actual costs. It provides quantitative data for a multiplicity of uses and decision making.

4. Accurate - The system must accurately compute customer charges.
5. Understandable - This is the most important standard. The customer should be able to determine how the charges for his job were computed. This also means that the charging policy must be simple, and not require an in-depth knowledge of computer operations. If the charging policy is designed to assist the user in making solid economic decisions, the price structure must be useable for budgeting and usage projections. The importance of this standard is evidenced by Nolan's discovery that only four percent of the users/managers he interviewed understood their charges well enough to take effective control actions [Ref. 33].
6. Promote Efficient Use of Resources - The system should encourage customers to use the computer systems efficiently. For example, it can discourage the use of emulation programs or the mounting and dismounting of private volumes.
7. Auditable - outside sources should be able to track each billable charge to its proper customer and ensure fair and equitable charges.
8. Cost Recovery - The system should recover the cost of operating the computer center. That is, the system should be so designed that costs are recovered only from the actual users of resources. This is particularly important when the object is to run the ADP budget with a zero balance, i.e., to recover all costs but no more.
9. Controllable Charges - Charges should be made on resources the user has control over. Not only must the user actually have control over the resource used, but he must perceive this control as well.

10. Stability of Charges - Constantly fluctuating prices will discourage the user from making sound economic decisions. However, the system must be permitted to change over time. As a rule, changes short of a major rate adjustment should be as a result of use rather than changes in the chargeback system.
11. Ease of Resource Measure Extraction - Resource measures for charging should be easily obtainable from the computer.
12. Adequacy of Billing Resources - A large enough set of billing resources should be chosen to make the system realistic, while not choosing so large a set that the charging system becomes unmanageable.
13. Flexibility - The system must change as needed to adapt to the needs of the organization. Chargeback is, after all, a tool utilized by management not an end in itself.
14. Allowance for Cost Estimating - The system should allow the user to forecast costs with a high degree of confidence. This is essential both for budgeting and in evaluating proposed new applications.

## N. CHARGEBACK SYSTEM ADVANTAGES/ DISADVANTAGES

### 1. Advantages

The decision on which chargeback technique to employ will at least be partially based on the perceived role of DP in the organization and the contribution an effective and efficient chargeback technique will have as part of the organizational control system designed by central management. To this end, a chargeback system is normally considered to have significant advantages in fostering efficient management of the computer resource as well as providing for significant improvements in cost control and resource allocation.

In the area of improving the management of the DP effort, one of the basic reasons for implementing a chargeback system is simply to conform to good business practice. Among other benefits, this helps to integrate DP into the company and can enhance the status of the DP department by dissipating the image of DP as an economic sink hole in which hard earned corporate profits were consumed. In addition, since the computer is paying its own way, increases in budget to enlarge the systems capacity are much easier to justify on an economic basis. Thus, chargeback becomes an economic information link between users and the data processing facilities, which should help in reducing communication difficulties and thereby promote cost control and the effective use of resources.

In addition, a chargeback system can be an effective method of resolving the problem of what rate of technological progress user's should try for, i.e., technological change and advancements proceed at a rate the user market will support. An important aspect of this advantage is that it can become a useful method to escape the cost-benefit labyrinth.

Perhaps most importantly, in order to ensure that expected benefits will be realized, a chargeback system makes management involvement in systems development and implementation more likely. Such involvement will enhance the likelihood of success. A chargeback system thus becomes a valuable aid to management in their planning and supervisory efforts.

The chargeback system also provides the potential for numerous organizational improvements by allowing for the basic accounting function of cost recovery and cost control. It also allows for the accurate statement of the total costs of user departments to the DP cost level. In addition, by allocating costs, the data processing department has better

economic justification of its resources and provides a method and criteria by which to evaluate data processing management.

A chargeback system also helps to ensure that DP functions in a cost-effective manner, especially if users are permitted to use an outside service bureau. In this situation there is an incentive for management to minimize cost and maximize the quality of service. It also permits the user to have some control over both the cost and the quality of the data processing service provided.

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In the area of resource allocation, a chargeback system can be expected to provide a number of substantive advantages. It provides a check and balance system with which to guard against providing unneccessary or unjustified services by harnessing user economic decision making and thereby regulating the demand for scarce computer resources. By encouraging user departments to assess realistically their use of the computer facility, a check is provided on the cost of the computer installation which can easily spiral upwards if the costs remain unapportioned. Thus, at the margin, users will request services only when they believe the benefits are greater than the costs charged against their budgets. If the computer function is treated as an overhead item, the incentive is to increase computer usage almost without limit. Users attempt to substitute the "free good" computer resources for other resources for which they must pay.

A chargeback system can also be expected to encourage people to judiciously use certain resources (e.g., by placing a high price on prime shift versus night shift processing) and result in better resource utilization by providing an incentive for users to use off-peak hours. With the use of flexible pricing this can assist in balancing the processing workload between peak and slack periods.

Thus, if the pricing structure is adequate, the chargeback system will do a good job of resource allocation-- deciding who gets what and when.

2. Disadvantages

As with all decisions, the implementation of a chargeback scheme does have some serious potential disadvantages. Cost recovery, as previously mentioned, could discourage computer use and users could become less likely to experiment and innovate, thus reducing the chances of significant gains. By placing the responsibility for assessing the value of projects on the user, a very parochial and short term view of the benefits to be gained from a project could be taken. The result can be a tendency to stagnation, missed opportunities, and hampered progress as a result of excessive preoccupation with costs.

Further, opponents of charging schemes argue that a good responsibility accounting system may serve to accomplish the same objectives as a system of internal pricing at a lower cost. They also argue that administering the chargeback system is costly and brings no extra real income to the organization; that it is hard to allocate charges fairly especially when the same output is used by multiple users; that the system favors wealthier organizations, so that worthy-but-poor projects may not get equitable treatment; and that users can be given accurate cost data on a continuing basis, even if a chargeback system is not used, thus combining the advantages of both policies.

# III. ECONOMIC CONSIDERATIONS

## A. PRICING AND THE ALLOCATION OF COMPUTER RESOURCES

The allocation of computing services is a classical problem of allocating a scarce resource. Therefore, the pricing mechanism must also serve as a rationing mechanism. The problem is how to flexibly adjust prices in order to effectively allocate the scarce resource and how to limit the budgetary impact of price fluctuations.[2]

When demand for computer services exceeds the available supply either the user is unable to obtain all of the computer time he desires or he is unable to obtain these resources when he would like them. With the advent of third generation computers a variety of ways to handle the allocation problem were suggested. In the late 1960's, Schmidt examined the problems caused by average costing procedures and recommended a system of flexible pricing and service priorities [Ref. 34]. Sutherland went one step further and proposed a bidding system for computer time [Ref. 35]. These two proposals are interesting for analysis purposes but fail the test of simplicity and do not allow for user budgetary planning. How then can the resource allocation problem be resolved?

The allocation problem must be approached with the understanding that some type of allocation scheme always exists. It may be called by any name but the demand for scarce resources will require an allocation scheme. There is simply no such thing as "no allocation". As Nielsen

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[2] It should be noted that NIF funding limitations allow for price changes only once a year and allows a three year period of cost recovery balance as the corpus is reimbursed.

points out, if resource allocation is not done explicitly it will be done implicitly. In most cases the default mechanism is a first-come-first-served (FCFS) system. This is particularly true when there is no rationing of computing, when everyone can submit as many jobs as frequently as he wishes. Of course, delays in turnaround act as an implicit rationing mechanism; as delays become longer and longer demand gradually becomes choked off.

This type of allocation method is only appropriate when all jobs are of equal importance. Since this is rarely the situation, resource allocation is accomplished via some grouping of administrative regulation such as not allowing jobs longer than "x" number of minutes during the prime shift in order to improve turnaround. The major problem encountered with administrative regulation resource allocation is that these regulations, exemptions, and other steps to temper the effects of FCFS system are often made or determined by the individual least qualified to make them, e.g., the computer operator, computer center manager, etc. [Ref. 36].

Theoretically, a dynamic flexible pricing structure subject to the instantaenous supply and demand forces could be recommended, via a bidding system for example. However, such a system could result in sharp price fluctuations as supply and demand vary over time and the overhead cost from a bidder and system perspective could be considerable. This system would also negatively impact on the ability of the users to set budgets. In practice, the price structure must then be relatively stable over time and emphasis must be placed on pricing over the long run. If a center tries to match cost and revenue in the short run, the use of charging may backfire. When a new system is installed there is generally substantial excess capacity. To recover costs with low utilization implies uneconomically high charges on

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the average. Thus users will be discouraged rather than encouraged to use the system. The situation is just the reverse in the latter part of the system's life. Demand has been built up, so utilization is high. This implies a low price (to avoid a profit if the goal is to break even). However, the bargain rates attract further demand to the already overloaded system. The use of long-run costs as a basis for setting average rate levels will mitigate this type of problem [Ref. 37].

Of course, the level of pricing could be adjusted to achieve a variety of management objectives. If the goal is to cover costs then the average price rate can be set to equal the long run capital and operating costs. If regulation of demand for the scarce computer resources is desired then prices can be raised to achieve this goal. The pricing structure can also be used to eliminate enforced computer idle time due to an insufficiency of user funds by lowering the price level. It can assist in maximizing the value of the computer services provided by adjusting prices downward for underutilized systems thus achieving a better overall system balance. Finally, it provides feedback about which service is most useful to the user and thus enables a more educated decision as to which type and mix of hardware and software to employ. This latter factor would be most useful when expansion of the system is considered.

## B. PRICING COMPUTER USAGE - AN ECONOMIC PERSPECTIVE

In the process of determining which chargeback approach to use there are a number of economic factors which must be considered. Economically, it is often assumed that there are increasing returns to scale in producing computer services, which stems from the behavior of the three main independent variables of the production function of computer

services: hardware, software, and manpower. Various studies verify (Sharpe, 1969 [Ref. 38], Schwab, 1968 [Ref. 39], Streeter, 1972/73 [Ref. 40, 41]) that mainframe manufacturers set up prices that behave according to Grosch's Law, which states that equipment performance is a quadratic function of its cost and thus reflects increasing returns to scale. Further, increasing returns to scale are realized by users of a large system from the use of software systems containing compilers, advanced operating systems, and the like.[3]

Since the variables affecting the production of computer services are subject to increasing returns to scale, the cost function derived from the production function will show that for any given production level the rate of growth of cost is lower than the rate of growth of output. Such a schematic cost curve is exhibited in Fig. 3.1. The total cost curve (TC) is typical of the case of increasing returns to scale and negatively sloping average cost (AC) and marginal cost (MC) curves are derived from it. The cost curves are characterized by marginal costs being lower than average costs for any given output level.

It has been argued that classical microeconomic theory establishes the conditions that pertain to an optimal internal pricing system for computer services, where an optimal price system from the organizations point of view is the one that allocates the limited resources in a way that maximizes utility for the organization. This optimal price determination is described in Fig. 3.2. From the organization's point of view, the optimal quantity of services and the internal price will be Q* and P* respectively. It is evident that this is the optimal solution and that at any

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[3] Increasing returns to scale means that if the inputs are doubled, output is more than doubled.

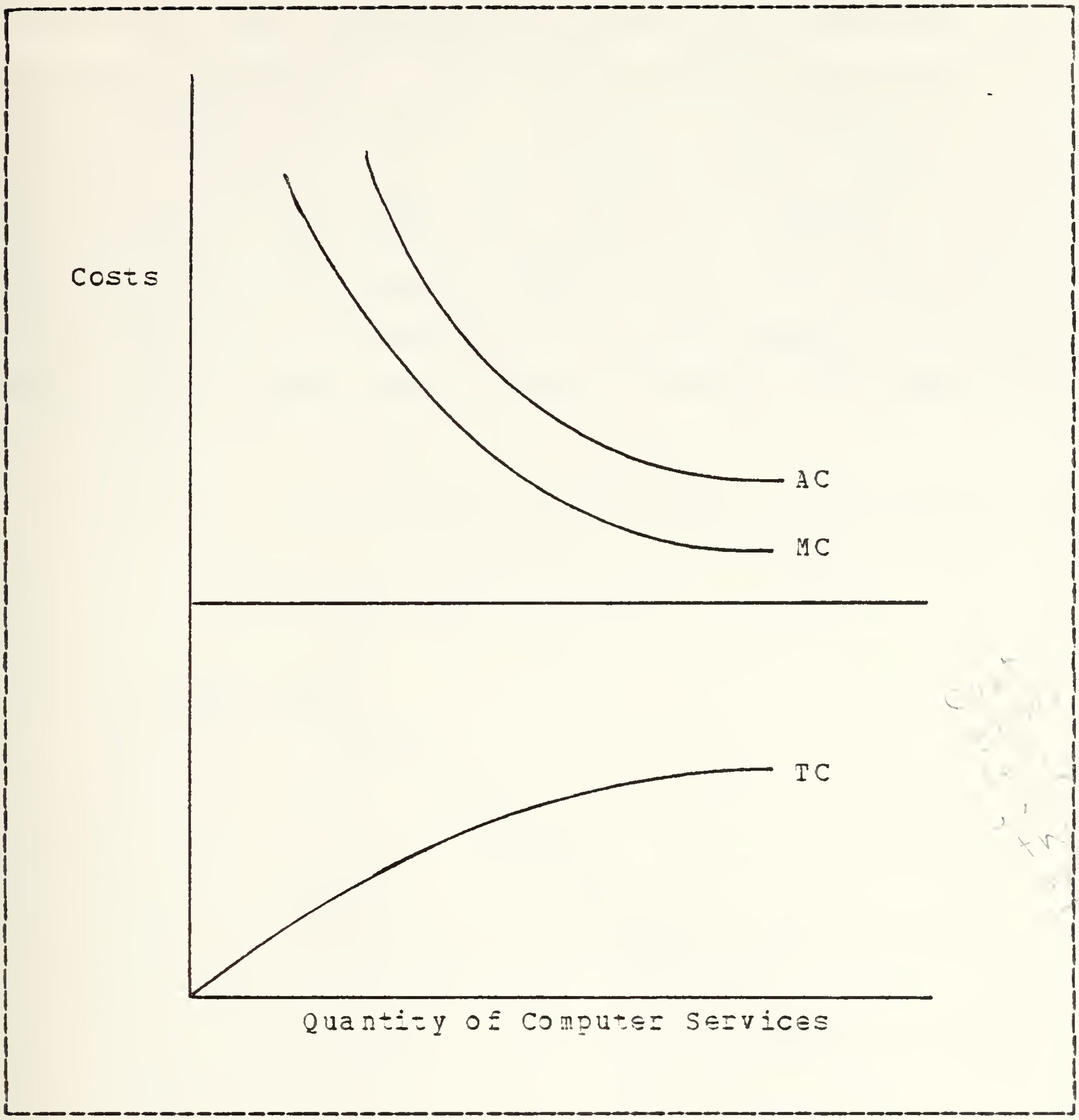

Figure 3.1 Cost of Computing Services.

other quantity, total profit of the organization as a whole will be lower. The conclusion is that the optimal price must equal the marginal cost of the selling department. The price will determine the optimal output of the computer center, that must be allocated judiciously among the various users. An optimal allocation prevails if the value of the

output for the organization cannot be increased by a different allocation. To achieve optimal allocation, price has to be identical for all users in the organization for a specific service. If a certain user faces a price higher than for the other users, the marginal revenue of services will be higher than for the other users. In such a case as new allocation of computer services and the allocation of a larger quantity of services to the user paying the higher price will increase total output of computer services in the organization [Ref. 42].

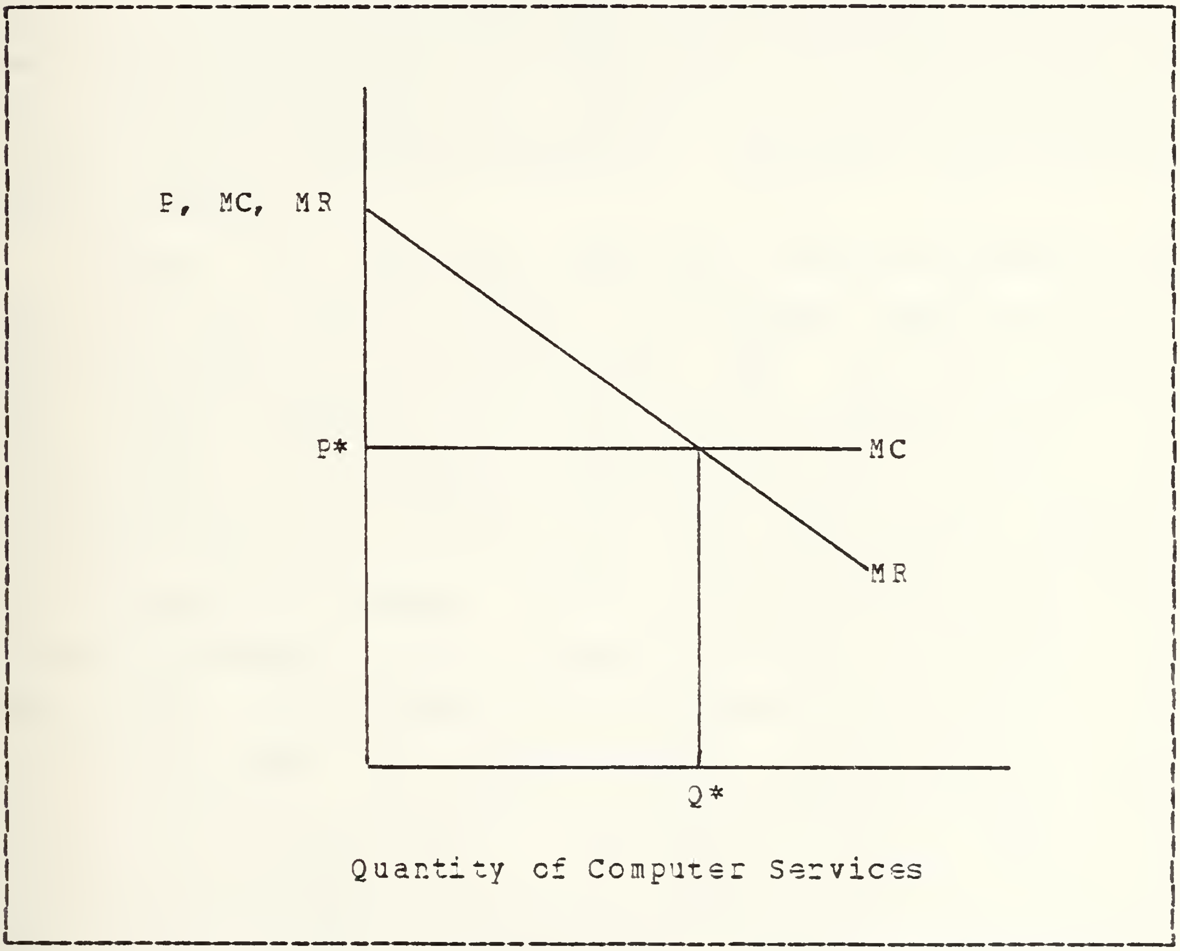

Figure 3.2 Price Determination of Computer Services.

In the Economics of Computers, W.F. Sharpe developed this same position arguing that the computer center should be established as a cost center rather than as a profit center. Sobczak in his Pricing Computer Usage article argued that, using classical microeconomic theory, a cost reflective accounting system does maximize the benefit produced by the computer dollar and that if a computer center operates to make a profit or sell computer services below cost, forces have been created that encourage suboptimum conditions. Thus, the price established for computer services must be a reflection of cost in order to maximize profit. (An obvious corollary to this argument is that a major design objective in developing a chargeback algorithm is to establish prices that reflect, as closely as possible, actual costs to the organization; contingent upon control system design).

In Fig. 3.3 the total cost (TC) curve represents the cost to the computer center of providing capacity for a specific quantity of computer work (Q). The total revenue (TR) curve represents the value to the organization of the work, with TR increasing proportionally with sales. Its straightline shape through the origin shows that price is constant at all levels of output. The slope of the TR curve is the marginal revenue. It is constant and equal to the prevailing market price, since all units are sold at the same price. The organization maximizes its profit at the output Q*, where the distance between the TR and TC curves is the greatest. At lower or higher levels of output total profit is not maximized. The bottom part of Fig. 3.3 represents the marginal cost and revenue curves that correspond to the TC and TR curves directly above. The MC and MR curves represent the cost and revenue of an additional unit of capacity. The optimum operating point for the firm is where the marginal revenue of an additional unit of work is

equal to the marginal cost, which is shown at Q* units. The total profits to the firm is equal to TR1-TC1 dollars. This is the profit maximization point; producing any other quantity of work will result in decreased profits.

The discussion above of microeconomic theory and its applicability to computer center operations is interesting but must be kept in perspective and suffers from some limitations due to the special market characteristics of a computer center. First, there may be factors or organizational objectives that central management feels are significant enough to compensate for the loss of total profit, e.g., they may wish to force the computer center management to perform efficiently and gauge his progress via the same business barometer as exists for other divisions-- profit. Second, establishing the internal transfer price at cost differs from the concept of price as viewed by the economist or businessman. The economist believes that price should exceed cost by only what is required to yield a competitive rate of return on invested capital. Often, he views a fair or normal profit as an element of cost. The businessman on the other hand, considers cost as only one of the factors determining price and feels that factors such as product demand and value to the consumer must be considered. Third, the term cost can be used in different senses such as fixed, variable, or semi-variable and this can complicate the process of analysis to a considerable degree.

There are also limitations built into the model that must be considered. First, for a given output under increasing returns to scale, the price will be established at the intersection of the marginal value (MR) and the marginal cost (MC) curves such that the computer center will not recover its total costs (Fig. 3.4). The price P1 and the Quantity Q1 are determined at the point where MC = MR, but at this price the computer center will sustain losses of

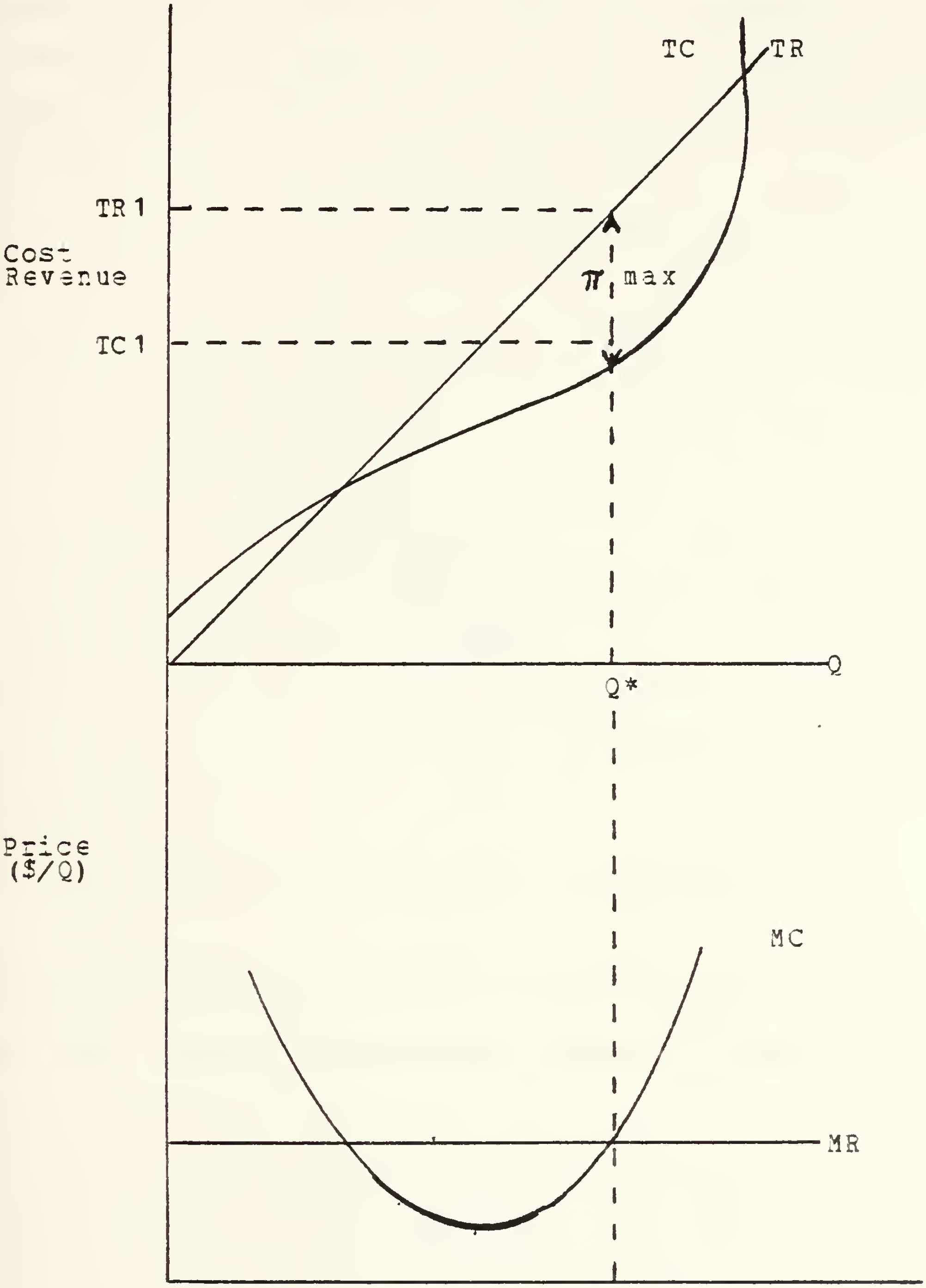

Figure 3.3 Computer Economics.

(C1 - P1)Q1 and will not recover its costs. Thus, when the production function is characterized by increasing returns to scale, price determination based on marginal costs does not result in recovery of total costs of computer services by their users, which may be a required factor of economic efficiency.

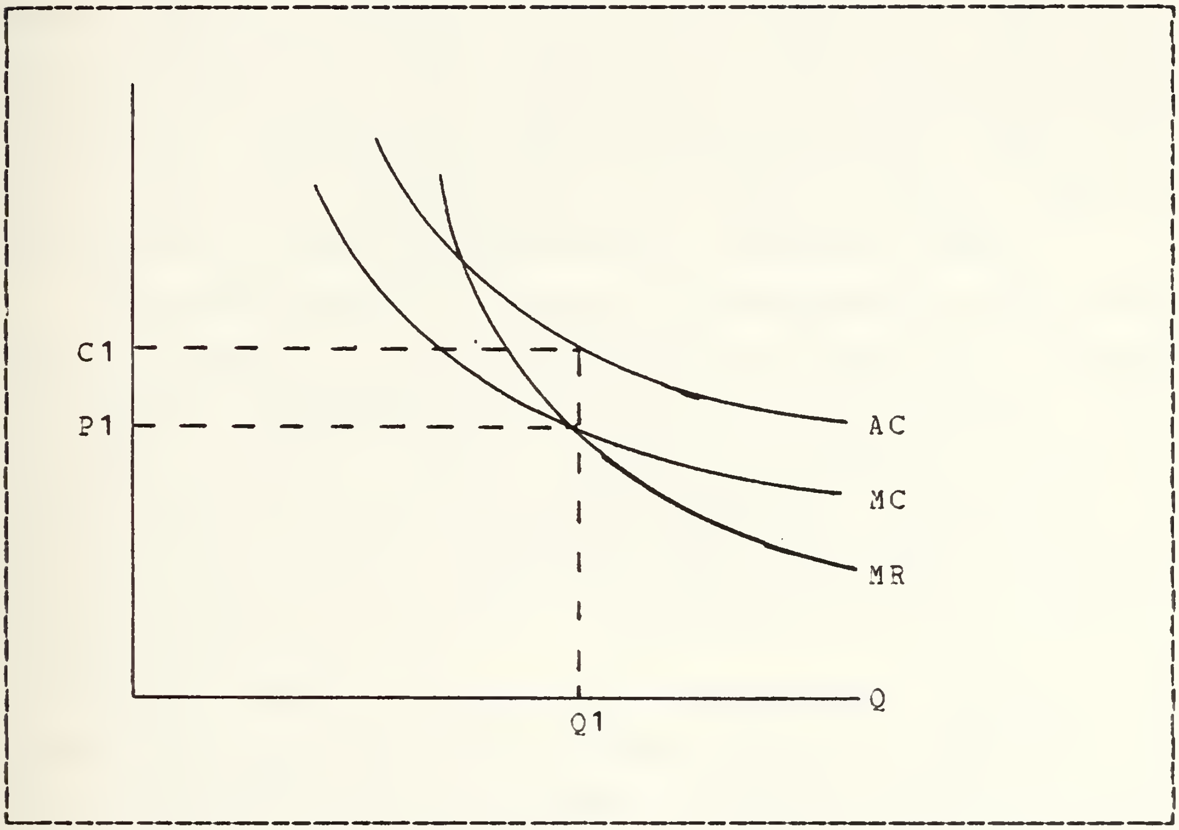

Figure 3.4 Price Determination: Under Incr Rtns to Scale.

There are other model limitations which must be considered such as non-homogeneity among users and the problem of estimating the demand schedules of the single users. Nevertheless, analysis of the problem from a classic microeconomic perspective does provide valuable insight into the problem and helps maintain perspective with regard to selection of a chargeback approach. For example, the

average cost chargeback algorithm approach does not fulfill the condition that the price of a unit of service must equal the marginal cost of its production and the flexible pricing approach will not guarantee recovery of total costs of the computer center since prices are determined by demand. Further, equality of prices and marginal costs are not necessarily obtained and users are not able to pre-evaluate costs versus benefits of acquiring computer services. A user can secure price or reaction time but not both. Finally, and perhaps most importantly, the economist assumes people and organizations operate rationally and that decision making by organizations is from a purely rational perspective. This is obviously not always the case.

Given the nature of classical microeconomic theory, what does it suggest to the organization anticipating a chargeback system implementation or reviewing the adequacy of an existant chargeback system? Sobczak and Borovits et al., in their respective papers draw some pertinent conclusions. A few of these will be discussed since they lend themselves very naturally to the study of chargeback systems implementation techniques.

First, with a large multiprogramming system, the accounting algorithm must allocate costs on the basis of system resources ( CPU, processor storage, channels, etc.) utilized to be cost reflective. Accounting on an elapsed time basis, simulated stand alone elapsed time, or simply on the basis of CPU usage does not properly account for resource usage. Such techniques are decidedly not cost reflective and it is not difficult to develop realistic examples when actions that reduce run time in a stand alone system, or result in decreased central processor usage, could actually be more costly in a multiprogramming environment.

Second, many accounting routines charge improperly for programs that use a large amount of a single resource. It is not absolutely correct to say a job should be charged in proportion to systems resources used, since high usage of a single resource can inhibit the use of the other systems resources. For example, if a job uses most of the processor storage that is available, central processor usage and other resource usage can usually be expected to be lower than average for the duration of the job, resulting in decreased revenue. Some multiprogramming accounting algorithms neglect this fact altogether. In others, there seems to be an attitude that a user should be penalized for such use, over and above the loss of revenue incurred, and an unreasonable surcharge is invoked. As illustrated, charging a job two or three times above cost is not better than charging a job two or three times below cost.

Third, complicated algorithms developed to properly account for such usage render it doubtful that the user could react sensibly to the algorithm complexity.

Fourth, from an economic perspective, the process of utilizing an accounting algorithm to discourage the use of expensive resources by placing an unreasonable surcharge on these resources is not optimal. There is no substantiation for charging any more than actual cost since if the resource in question is, in fact, expensive, a cost sensitive algorithm will reflect this.

Fifth, similar to above, the process of structuring rates so as to discourage inefficient resource usage by using an overcharging penalty philosophy may in effect encourage an inefficient allocation of resources.

Sixth, as previously mentioned the inherent economic weaknesses of the flexible pricing and average cost methods of charging for computer services should at least be recognized. Both violate the principle that the price of a unit

of service must equal the marginal cost of its production (amongst other weaknesses).

# IV. NIF FUNDING

The decision that NARDACs would be NIF funded activities simultaenoulsy mandates the implementation of a chargeback system and limits the chargeback technique selection possibilities. Thus, a thorough understanding of the NIF process, the concept of working capital funds, the NIF cost accounting system, and rate stabilization policy is necessary to properly select the optimal chargeback technique.

The Navy Industrial Fund (NIF) was established by Congress as a means of helping certain Navy activities to function more efficiently and in a business-like manner by freeing them from many of the worries arising from the total dependence on the cycle of annual appropriations. The NIF appropriation has an indefinite life from which qualified commercial/industrial activities can be given working capital to operate on a revolving fund basis similar to private enterprise. The term "revolving fund" means that working captial (called NIF corpus) is used to finance operations from the time that specific work is begun to the time that payment is received from the customer [Ref. 43].

In basic concept, a revolving fund commences operations with an initial funding by the Congress. The issuance of a NIF charter from the Assistant Secretary of Defense (Comptroller) allows the Navy to capitalize and finance the NIF activity as a seperate operating entity. The activity then functions in a similar fashion to a commercial corporation, possessing its own assets, liabilities, and equity. The equity (in a balance sheet sense) of the NIF activity is called the "corpus" and represents the working capital of the activity.

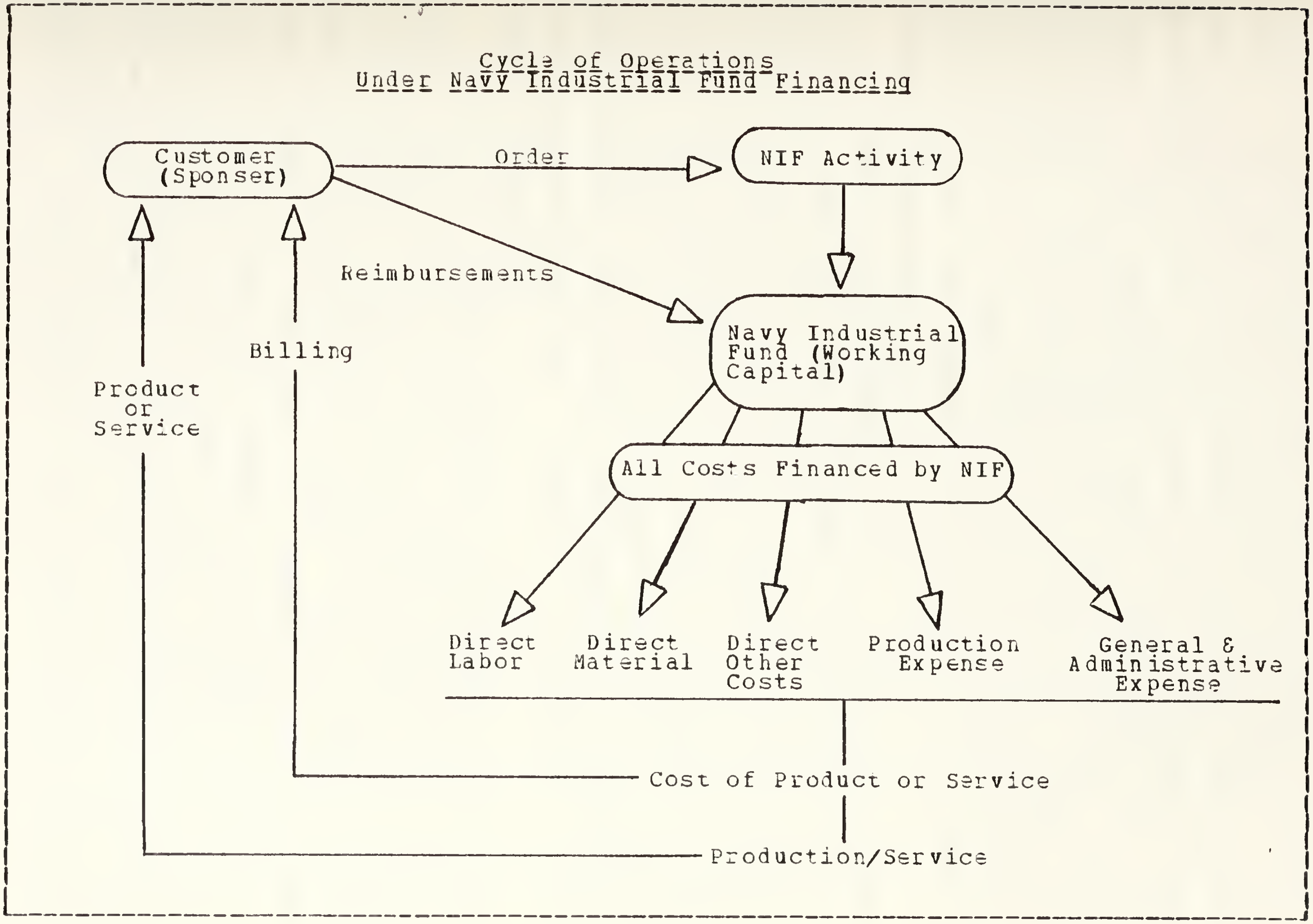

Figure 4.1 NIF Cycle of Operations.

Having received an initial funding, the Industrial Fund Activity would then take orders for work from Navy cutomers, perform the work with dollars from the corpus of the revolving fund, bill the customers for the work, and receive reimbursements from the customers (from their appropriated money). The reimbursement would theoretically put the corpus of the revolving fund back where it started. Since billings are generally based upon "stabilized" rates, the NIF activities tend to collect cash from their customers at a slightly variant rate than the previous outflow. Hence in the short term, NIF activities can be seen to either make a profit or experience a loss.

At times the NIF revolving fund is augmented by direct influx of cash from appropriations. In the event that a significant expansion of NIF business were envisioned, it might be necessary to increase the corpus of the NIF through such a direct appropriation. On a more or less annual basis cash is injected into the NIF in order to mitigate the need for "stabilized" rate changes brought about by pay raises or other escalating costs which are recognized in supplemental appropriations [Ref. 44]. Figure 4.1 illustrates the NIF cycle of operations.

There are several important advantages of the NIF concept which deserve mention. First, a contractual buyer-seller type relationship is established between the customer and the activity, requiring the activity to define the task and accurately estimate the costs. This fosters a cost consciousness and eliminates the concept of free supplies and services. This also enables the customer to prepare a better and more realistic appropriation budget request from Congress to pay for the work. Second, the cost accounting system relates costs to a specific job and makes it possible to establish a "total" cost per unit for products and services. This is essential for maximum control of costs,

developing standard pricing, and projecting accurate cost budgets. Because of cost visiblity, the buyer is able to be a critic, which should result in lower unit costs of production. Further, since the customer pays for the requested services, customers tend to limit their request to that which is actually needed. Third, the revolving fund provides additional flexibility by being free of the congressional appropriation cycle and, therefore, provides for responsible and efficient local management. Fourth, duplication of comparable facilities is reduced through consolidation of similar activities into the NIF organization. [Ref. 45].

Department of Defense Directive 7410.4, _Regulations Governing Industrial Fund Operations_, lists the following objectives of Industrial Funds:

1. Provide a more effective means for controlling the costs of goods and services....
2. Create and recognize contractual relationships....
3. Provide...financial authority and flexibility required to procure and use manpower, materials and other resources effectively;
4. Encourage more cross-servicing....
5. Support the performance budget concept by facilitating budgeting and reporting for the costs of end products....

It is clear as far as the Department of Defense is concerned, industrial fund accounting is a management tool. The intent is to provide for more effective management through the use of the industrial fund customer's funds as well as those of the industrial fund activities.

A major limitation imposed on the computer center when selecting a chargeback approach is that with NIF funding the financial goal is to break even, i.e., NIF activities are to run on a nonprofit basis. Costs are billed out to customers

(some direct costs, some indirect costs), and in theory provides for total reimbursement of costs incurred. This means the NIF activity should charge the customer the same price as it costs the NIF activity to do the work. The NIF fund then "revolves" in that payment received from the customers replenishes the working capital fund which is continually used to finance operations until payments are received. The attempt to break even requires rigorous control of costs, because if NIF has cost overruns, it incurs losses which is considerably different than just making a little less profit, as in the case of private industry. This breakeven requirement, cost control, and cost allocation is no mean task for any organization and is potentially more difficult for a computer center because of the nature of computer operations in a multiprogramming environment and the concomitant problem of cost projection.

Finally, even though NIF operations for each activity are budgeted on a "break even" basis, in reality there are annual profits or losses which temporarily increase or decrease the capital of the fund. This is considered in the next budget preparation by the NIF activity and rates are adjusted to bring the accumulated operating result back to zero. As a result of Department of Defense (DOD) rate stabilization actions for NIF activities (see below), the break even point in operations now occurs at the end of a three year cycle, rather than at the end of each fiscal year. The three year cycle provides for zero gain/loss on a cumulative basis [Ref. 46]. Further, rates established for NIF activities are expected to remain in effect for the entire fiscal year, and may be changed only upon approval of the Assistant Secretary of Defense (Comptroller).

## A. RATE STABILIZATION AND NIF

Rate stabilization had its genesis during the 1970's when the economic situation became characterized by rapid inflation and shortages in petroleum and other materials. NIF activities were allowed to adjust their rates upward on a quarterly basis to keep pace with inflation and cover their increasing costs. This was beneficial to the NIF activities in that they could adjust their rates four times a year to insure they operated on a "breakeven" basis. However, this was not very beneficial to the customers who had to obtain their funds in the form of appropriations from Congress. The end result was that appropriated funds were used up faster than expected and budgeted work was not being accomplished in the same fiscal year as programmed [Ref. 47]. This had a direct affect on fleet readiness and was embarrassing to the customers who had to go back to Congress and request more money.

Faced with this situation and the knowledge that Congress would not approve any changes in their funding system, DOD managers determined that their best approach would be to have the NIF activities stabilize their rates and absorb the cost increases or decreases through their corpus. This concept was called Rate Stabilization [Ref. 48].

The Rate Stabilization program was implemented on July 1, 1975, for all DOD industrial funded activities. The stated purpose of rate stabilization was to give customers of NIF activities firm prices for goods and services prior to the fiscal year budget process, and to maintain those price levels throughout the year of budget execution.

NAVCOMPT Instruction 7600.23B provided amplifying guidance as follows:

> "In developing and establishing rates, each activity will adhere to the principle of aligning rates to recover operating costs. An activity should devise a sufficient number of rates to ensure that the rate system is a reasonable model of the actual cost of performing the various catergories of work or services covered by the rates. Stabilized rates submitted by the activities will be reviewed and adjusted by the Activity Group manager, to provide the necessary charges to offset the total prior years gains or losses thereby achieving zero profit and loss in the Accumulated Operating Results Account of the Activity Group. Gains and losses will normally be fully offset during the year following their occurrence, and will be reflected uniformly in the rates of the Activity Group. Changed conditions resulting from the Office of the Secretary of Defense review of the Activity Group manager's A-11 Budgets, and changes in the customer programs occurring during the budget review cycle will result in stabilized rates being again reviewed and additional changes made when appropriate."

This would allow customers subject to annual appropriations to budget for cost escalation and thereby aid in sloving the problem.

Therefore, a primary reason for implementing stabilized rates at NIF activities was to benefit the customer by giving them the ability to plan customer projects based on known rates rather than estimates. Secondly, it eliminated the adverse effects of cost growths to the customer during a fiscal year. Annual accounts are precluded by the Office of Management and Budget (OMB) from budgeting for cost escalation. They can, however, budget for stabilized NIF rates which do provide for inflation, and thereby include anticapated cost escalation in their annual account budgets.

Each activity establishes fixed rates which may be expressed as costs per man-hour, man-day, unit of output, unit of input, or any other manner which best suits the nature of the effort. An activity may have a single rate or as many rates as are warranted. The activity group commander, such as Commander Naval Sea Systems Command (COMNAVSEASYSCOM), approves the number and kinds of rates to be established based on each activity's organizational structure, diversity of workload, and other management considerations.

In developing and establishing rates, each activity adheres to the principle of aligning rates to recover operating costs. An activity should devise a sufficient number of rates to ensure that the rate system is a reasonable model of the actual cost of performing the various categories of work or services covered by the rates. Stabilized rates are submitted by the activities at the outset of the annual NIF Budget Cycle, which begins approximately 15 months prior to budget execution. The rates are reviewed and adjusted by the activity group manager to provide the necessary changes to offset the total prior year gains or losses, thereby achieving zero profit and loss in the Accumulated Operating Results Account of the activity group. Gains and losses will normally be fully offset during the year following their occurrence and will be reflected uniformly in the rates of the activity group. Changed conditions resulting from the Office of the Secretary of Defense (OSD) review of the activity group managers' budgets, and changes in the customer programs occurring during the budget review cycle will result in stabilized rates being again reviewed and additional changes made when appropriate. The final stabilized rates are determined upon conclusion of the OSD/OMB review.

Rates established in compliance with NAVCOMPT Instruction 7600.23B dated June 6, 1978, and entitled "Rate Stabilization Program for Industrially Funded Activities", are expected to remain in effect for an entire fiscal year and are used to bill customers. Rate changes during a fiscal year are rare and may be made only upon the approval of the Assistant Secretary of Defense (Comptroller). Requests for rate changes must be made by appropriate justification.

Any variance between stabilized rate billings and actual costs become profits or losses to the NIF activity and are absorbed by the corpus. By the time a profit or loss is realized, however, the next year's rates have already been established. Consequently, the initial year's profit or loss is not offset until the establishment of the third years rates. This extends the NIF activity's operations from an annual to a cumulative triennial basis [Ref. 49].

## B. RATE STABILIZATION IMPLICATIONS

While these stabilized rates do allow the user to develop a meaningful budget and reduces administrative and paperwork expenses, it places a heavy burden on the NARDACs to correctly price their service and properly anticipate demand as well as their operating environment. It can undermine the ability of the NARDAC commander to control the financial position of his command by limiting possible adjustments to meet financial targets to manipulation of internal overhead functions. Further, inaccurate midrange anticipation of inflation, utility rates, and pay raises may also place the NARDAC in an untoward fiscal position.

There are several other negative implications of rate stabilization and NIF that must be anticipated by the activity commander. Consider, for example that in order for the actual FY 1984 NIF rates to be consistent with the estimates contained in the President's FY 1984 Budget, the original rates proposed by the NIF activities (in the May 1982 timeframe) have to be modified to incorporate changes made by the Activity Group managers, NAVCOMPT, and DOD. This update is normally accomplished in the early spring of the next year. Consequently, NIF FY 1984 stabilized rates will be announced to NIF local customers during the period of April/May 1983. Since Navy customer budgets are priced from

the "bottom up" in the budget process, it is interesting to note that the NIF rates (for the President's Budget fiscal year) are not available to NIF customers at the time of preparation of the President's Budget. Rather they are actually available a year later, in time for the construction of the apportionment year column of the next year's President's Budget (the fiscal year 1984 column of the fiscal year 1985 President's Budget) [Ref. 50]. In effect, although the program stabilizes rates almost two years ahead of time, it is actually happening about a year later than would be necessary to accomplish its goals at the local activity customer level.

Another rate stabilization implication centers around the question of whether rates should be national or regional. That is, given that NIF rates are stabilized, does it make sense that many different NIF activities would have different stablilized rates for the same service? This situation currently exists for each NIF activity within an Activity Group and for common services available from numerous groups. It exists because of two basic reasons:

1. Local NIF activities build their rates based on local costs (which are regional).
2. Different Activity Groups have different factors built into their rates to recoup/return losses or profits to achieve the zero accumulated operating results objective [Ref. 51].

This is an implication of major concern to a NARDAC Commanding Officer who because of inefficiencies from obsolete equipment, or excessive utility costs vis-a-vis other "competitive" NARDACs, can find himself in the unenviable position of charging a far higher rate for similar services that a contemporary located eleswhere who is blessed with newer equipment and more favorable utility charges.

Perhaps most importantly is the not so subtle impact that rate stabilization can have on the NIF activity financial structure. The essence of rate stabilization is that annual rates are set for the entire fiscal year. The combination of rate stabilization and NIF budgeting has created a situation wherein rates are set one to two years in advance of actual execution, and wherein the rates ultimately charged, represent modifications by the NIF Activity Group Manager, NAVCOMPT, and OSD, to those submitted by the individual NIF activity. As a consequence, individual NIF activity commanders have lost the ability to directly determine or change stabilized rates once a flaw has been observed in execution. In point of fact, NIF activities are told what factors to employ in the construction and subsequent modification of rates prior to their execution.

This has resulted in a rather substantial loss in autonomy on the part of the NIF activities in that they are no longer in control of the inflow of resources to their command and consequently cannot in a major sense, control positively the value of profit or loss for a particular period or their cash balance. Since NIF activity commanders have (in part) been evaluated by their superiors on the basis of the financial position of their individual NIF activities, they have tended to view rate stabilization as precipitating a loss of the previously enjoyed NIF decentralized autonomy. This is, rate stabilization has imposed a degree of centralized control over a portion of their operation which is employed in their individual evaluation. From a performance measurement perspective, the basis for measurement must extend over a three year period, since a NIF activity commander will be diliberately sustaining "losses" one year to offset the "profits" of another, and vice-versa. The value of such a long-term performance measurement vehicle is questionable, especially when

considered in light of the activity commander's relatively short tour length.

This situation tends to send rather poor messages to the individual NIF activities in relation to responsibility for NIF financial operations. There are real questions as to what actions are expected relative to running at a loss or in a negative cash position. NIF activities have responded differently to negative profit or cash positions, either sneaking in rate increases or speeding up billings to obtain a one-time increase to their cash balance. Obviously, unapproved rate increases or continuous rapid billings for small amounts of cash are unproductive in the big picture.

Finally, rate stabilization may tend to obscure the true costs of operations on a short term basis. For example, if increases in fuel and utility costs are not passed on to the customer due to stabilized rates, the customer has no financial motivation to conserve energy.

The essence of the problem with rate stabilization is that the Navy is attempting to centrally control some aspects of the operation while functioning in a decentralized financial structure. In order to achieve a higher measure of control over liquidity, the Navy will have to either return to decentralized operations of the past or move towards greater centralization and perhaps abandon the current financial structure which is activity oriented. Such a centralization and change in NIF accounting introduces a whole new spectrum of management and financial control implications which would be quite difficult for the Navy to sort out [Ref. 52].

From the discussion above it seems obvious that the current control system has been hurt by rate stabilization and it should be abandoned as a concept which has served its purpose and should be done away with in these more predictable economic times.

## C. NIF ACCOUNTING SYSTEM

Both the NIF budgets and the execution reports are in the format of balance sheets, income statements, and selected statistics. A simplified balance sheet format is presented in Figure 4.2. As can be seen, the NIF carries the more or less normal asset accounts encountered in a balance sheet. However, at the end of fiscal year 1981, NAVCOMPT directed all NIF activities to capitalize into the NIF the book value of all land, equipment, or other fixed assets. This capitalization set the stage for the inclusion of depreciation charges in FY 1982 stabilized rates and authorization of NIF procurement of fixed assets (commencing in FY 1983). Prior to FY 1983, NIF fixed assets were financed directly by procurement appropriations and "loaned"

| Assets | Liabilities |
|---|---|
| Cash | Accounts Payable |
| Accounts Receivable | Accrued Expenses |
| Work-in-Progress | Advances from Customers |
| Prepaid Expenses | |
| Equipment/Land | |
| | Owner's Equity |
| | Corpus |
| | Net Capitalization |
| | Equity Reserves |
| | Accumulated Operating Results |

Figure 4.2 Typical NIF Balance Sheet.

to the NIF for use without charge [Ref. 53]. Although this capitalization concept makes sense from an economic and accounting perspective, it complicates the development of a chargeback algorithm and removes some of the built in advantage that NARDAC's had over other computer service facilities. Further, there could be a very real problem capitalizing some of the NARDAC's obsolete equipments; it could exaccerbate price disparities between respective NARDAC's for similar services; and it will force management to address the issue of whether or not software and databases are capital assets. Certainly, if software and recovery or maintenance of a database is accomplished with NIF funds, then the database should be considered as an asset. If this is the case then the greater problem of valuation and expected life of the database must be determined if this asset is to be properly depreciated and expensed.

The major liabilities of the NIF are quite similar to those of a business; accounts payable and accrued expenses. The principle accrued expenses in the NIF are for wages owed, leave due to employees, and other (resulting from contractual relationships outside the NIF).

The owner's equity section of the balance sheet has four main accounts. The corpus account represents the current balance of the initial capitalization of the NIF. The net capitalization account is the owner's equity offset for the value of fixed assets which were capitalized commencing in fiscal year 1982. The accumulated operating results and equity reserves accounts are employed in a "pro-forma" sense to drive NIF cash inflows greater/lesser than costs. The accumulated operating results account is similar to the retained earnings account in a business and records the net profit or loss of the NIF since its inception. As noted, the NIF has a no-profit objective thus, NIF rates for FY

1984, for example, would be set equal to fiscal year 1984 costs plus/minus the required increase/decrease necessary to produce zero accumulated operating results at the end of the budget year's program.

Prior to fiscal year 1982 the NIF operated under the assumption that if accumulated operating results were zero, the cash balance would be acceptable. In effect the NIF did not have a cash objective incorporated into its rates. Commencing with fiscal year 1982, coincident with the impending policy change in fiscal year 1983 to allow NIF to procure its own fixed assets with NIF resources, a new "equity reserves" was established to allow the NIF to execute a cash objective in its rates. Budgeted increases or decreases in this account in the President's Budget, like the accumulated operating results account, can be used to drive budget year rates which are greater or lesser than costs and consequently increase or decrease the cash account balance.

The income statement (see Figure 4.3) employed in the NIF can be viewed as having three main sections; revenue,

| | | |
|---|---|---|
| Revenue (in millions) | | $13,607 |
| Less Costs (in millions) | | |
| Costs Incurred for Customers | $13,627 | |
| Change in WIP | 31 | |
| Cost of Goods or Svc's Produced | | -13,596 |
| Net Operating Results | | 11 |

Figure 4.3 Basic NIF Income Statement.

costs and operating results. Revenue is recognized in the NIF based on two basic methods; recognition based on project completion (normally for work performed in-house) or revenue based upon progress of work on the customer order (normally for work being accomplished under contract) [Ref. 54].

## D. COSTS OF AN INDUSTRIAL FUND

Costs tend to be catergorized in NIF reports either by their origin (personnel, material, contracts, other) or their application (direct, production overhead, etc.). It is important to note that the costs attributed as incurred by the NIF activity may not really represent the full costs of the NIF activity.

### 1. Costs Generally Not Borne by the NIF

The costs of military personnel are directly financed by the military personnel appropriation and thus are not directly borne by the NIF. As a consequence, the NIF budget and NIF charges to DOD customers do not reflect the costs of military salary or retirement. In the civilian personnel arena, the costs of the civilian retirement program are not directly related back to the NIF. Prior to FY 1983, the costs of investment items in support of the NIF (buildings, equipment, etc.), were borne directly by procurement appropriations and "donated" to the NIF. As a consequence, prior to FY 1983 these costs were not included in the NIF charges to DOD customers. As discussed earlier, these costs are now financed by the NIF and passed on to NIF customers through the cost mechanism of depreciation.

### 2. Costs Borne by the NIF But Not Charged Against Customer Orders

In certain instances, the mission of NIF activities includes functions which are not directly related to the industrial process in support of NIF customers. Functions, such as military support or maintenance of test ranges, have been included in the mission of the NIF activity for management control but are financed by the NIF activity's parent command (normally the Activity Group Commander) rather than the NIF activity's customers. Generally such costs would be attributed to general and administrative overhead by inputs consumed and then "zeroed out" by the application of resources from the related parent command.

### 3. Cost Accounting Within the NIF

The accounting system employed by the NIF features double-entry bookkeeping, accrual accounting, internal control over all transactions, and integration of cost accounting records with the general ledger accounts. The specific details for a particular NIF activity vary according to the type of activity, and are spelled out in the appropriate (activity group) NAVCOMPT handbook for the activity involved.

There are certain traditionally required (internal) financial controls at all NIF activities:

Cost estimates and controls for monitoring costs - to preclude costs from exceeding the amounts authorized on customer orders,

Accounting Controls - to prove the accuracy and propriety of transactions and accounting records,

Budgetary Controls - which require that the financial plan and accumulation of actual data be on the same basis.

When a customer order is received by a NIF activity, it is assigned a unique job order (or job orders), to which all work is charged. Costs are accumulated and customer billings are made on the basis of these job orders. As is shown in Figure 4.4 there are essentially three types of costs.

Direct costs (labor, labor acceleration, material, construction costs, etc.) are charged directly to the job order as work performed. Production overhead costs (supervision, contract administration, etc.) are distributed to each job order by use of a predetermined rate within the cost center. General and Administrative overhead costs (management, comptroller, civilian personnel office, etc.) are distributed to a job order by the use of a predetermined rate which is actually based on the budgeted output of the entire NIF activity (all cost centers).

Overhead is applied to each cost center as shown in Figure 4.5. All production overhead costs for the cost center for the upcoming period are estimated and totaled. This total is then divided by the budgeted direct labor hours that will be incurred within the cost center, giving the production overhead rate for the cost center. General and Administrative (G and A) overhead costs are estimated and totaled for all cost centers of the NIF activity. The total G and A overhead costs are divided by the total number of budgeted direct labor hours available for all the productive cost centers, giving the G and A overhead rate. For each cost center, the predetermined overhead rate is the sum of the cost center production overhead rate and the G and A overhead rate.

The predetermined overhead rate is then applied to each actual direct labor hour worked, resulting in the applied overhead, which is compared to the actual overhead. The difference between the applied and the actual overhead

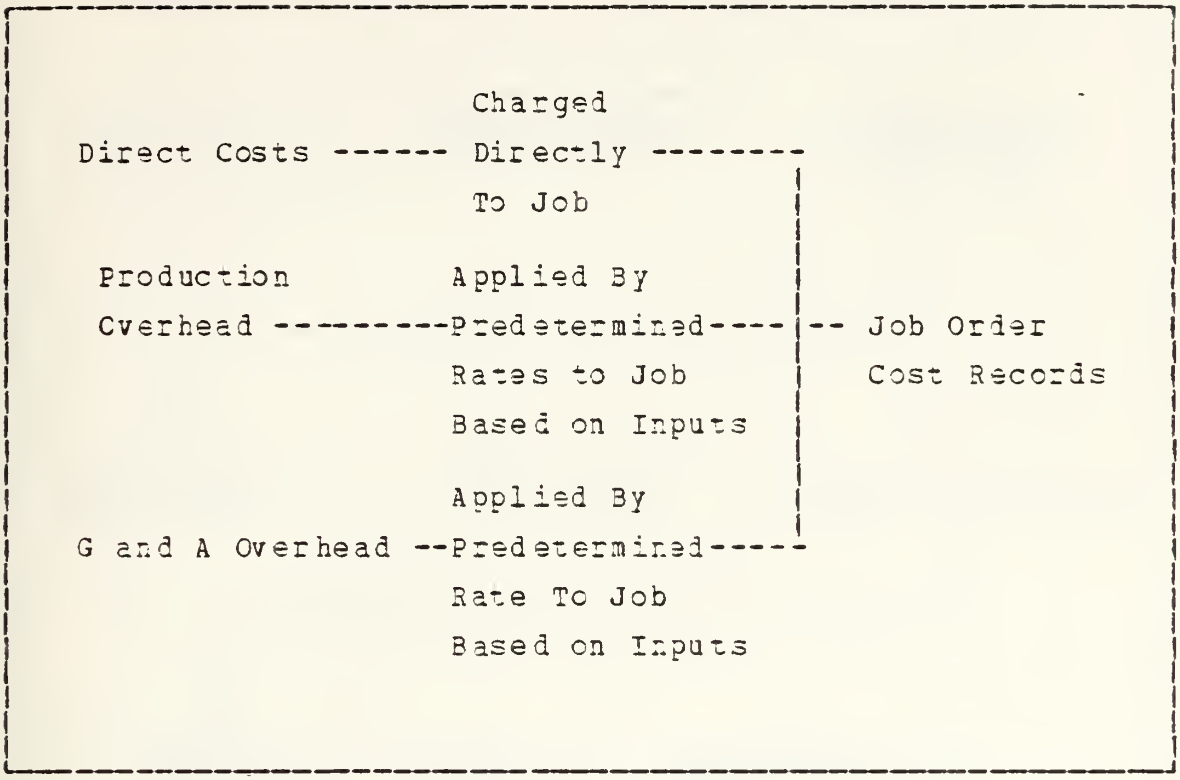
Direct Costs
Charged Directly To Job
Production Overhead
Applied By Predetermined Rates to Job Based on Inputs
G and A Overhead
Applied By Predetermined Rate To Job Based on Inputs
Job Order Cost Records

Figure 4.4 NIF Job Order Cost Basis.

is accumulated as an overhead variance, and can be the source of a measure of profit or loss for the accounting period involved. These variances are considered when next recomputing the predetermined overhead rates.

Based upon NAVCOMPT's guidance, some functional areas of NIF activities are considered as service centers. These functional areas (like internal data processing) actually serve other cost centers in the accomplishment of their tasks. The budgeted costs of these service centers are (like overhead) allocated to the respective cost centers as production overhead costs. As the G and A overhead area, the actual costs of these service centers are likely to be at variance with those budgeted and distributed; consequently, these service-center cost variances can be viewed as contributing to the profit or loss of the NIF activity [Ref. 55].

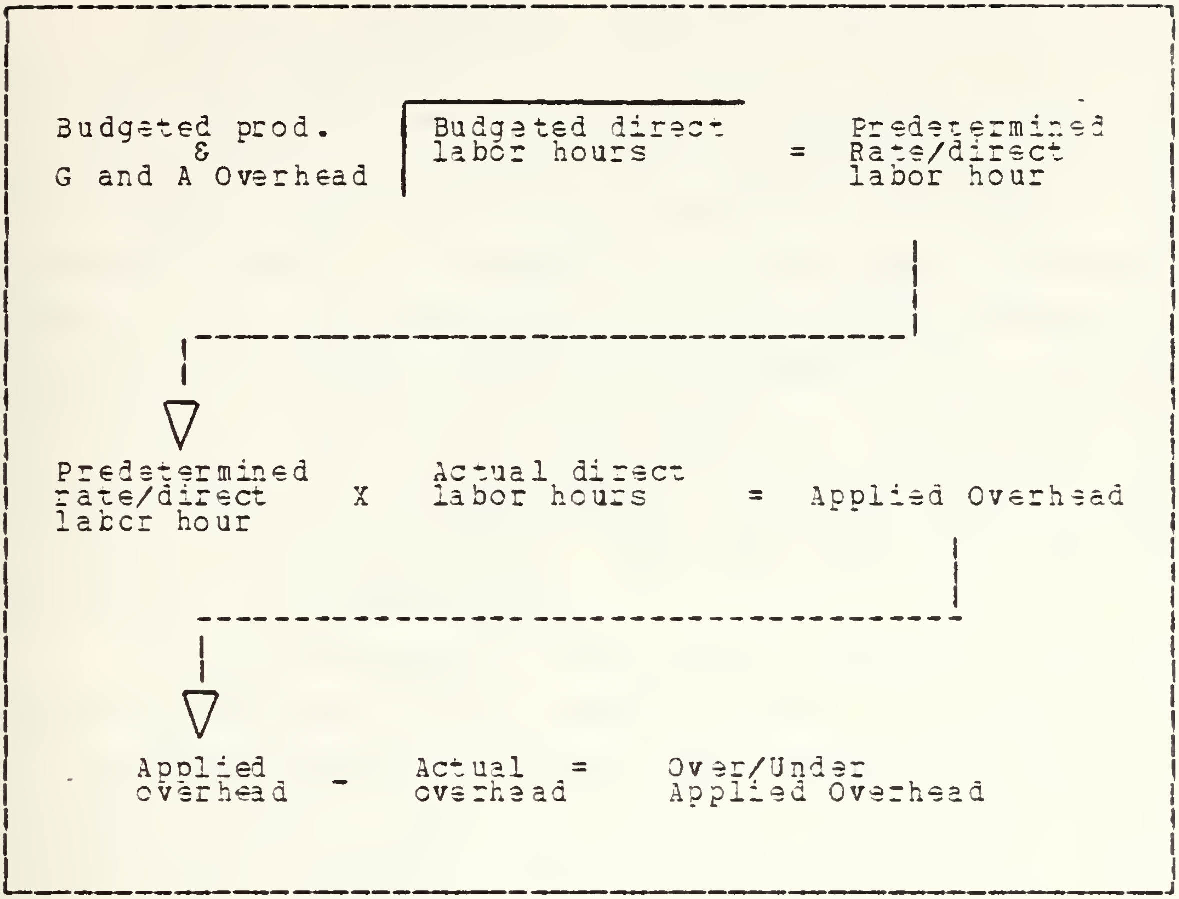
Budgeted prod. & G and A Overhead
Budgeted direct labor hours
=
Predetermined Rate/direct labor hour
Predetermined rate/direct labor hour
X
Actual direct labor hours
=
Applied Overhead
Applied overhead
-
Actual overhead
=
Over/Under Applied Overhead

Figure 4.5 Application of Overhead.

### 4. NIF Charges to Customers

There are three main approaches employed by the NIF in charging; cost reimbursable, predetermined rates, and fixed price. All three of these approaches have as their essence the idea of recovering costs incurred in support of a customer's order. The differences between the three are in the areas of adhering to previously budgeted estimates, the time horizon for returning/recouping past profits/losses and the degree of motivation to the NIF activity to reduce costs.

The cost reimbursable approach essentially involves accumulating direct and indirect costs in such a manner as to allow charging these costs to a customer. Since the advent of rate stabilization, this approach has been for the most part limited to material consumed in a job or for contracts issued in support of a particular customer's order. While this approach has fallen into a measure of disuse, as a result of rate stabilization, it is still widely used internally by NIF activities to view performance on individual jobs, and when providing certain work for non-DOD entities (in such cases billings would include recovery of the government's cost for military personnel, retirement, and assets used).

The predetermined rate approach generally involves charging customers a preset hourly, daily, or monthly rate for services rendered. In many cases the predetermined rate includes a factor which is intended to return/recoup budgeted profits or losses (from previous periods) so as to allow the NIF activity (or activity group) to return to zero accumulated operating results at the end of the fiscal year (as budgeted). Today, predetermined rates in the form of stabilized rates, are the most common of the three approaches employed in charging NIF customers.

A fixed price customer involves the agreement between a NIF activity and its customer to perform specific work for a specific fixed price. These customer orders normally evolve from either the cost reimbursable or predetermined rate approaches as a consequence of negotiation between the customer and the NIF activity. In the past, these sort of agreements have tended to be negotiated when a praticular customer order was near fifty percent completion, and would provide the basis for firm obligations on the part of the customer, and the opportunity to benefit from good performance on the part of the NIF activity.

Charges to customers via these three approaches can be viewed as having been either based on inputs to or outputs of the process. Inputs would include such factors as hours worked or material consumed while outputs would be the products or services produced. Generally speaking, cost reimbursable orders are normally priced based on inputs, fixed price orders are normally based upon outputs, and predetermined rates could be based upon either the inputs or outputs of a process [Ref. 56].

# V. IMPLEMENTATION OF A CHARGEBACK SYSTEM

## A. IMPLICATIONS OF A CHARGEBACK SYSTEM

The history of chargeback systems, its relationship to the defined organizational control system, and several of the more important and controversial extensions such as cost recovery vs profit center, pricing and the allocation of computer resources, charging for systems and programming, etc., have been addressed. In addition, the objectives, reasons, and standards pertinent to chargeback systems have been briefly reviewed along with its advantages and disadvantages. Finally, the concept of chargeback from a microeconomic framework was reviewed and a close look at the NIF funding process was conducted. Prior to recommending a chargeback methodology, a brief discussion of some of the more subtle implications of a chargeback system is in order.

First, if a chargeback system is introduced after computer operations have been implemented, the attitudes of the user and the provider of computer services may change toward one another. The DP manager who was once a collegue is cast in the role of an external supplier with his own financial targets and his own marketing strategy [Ref. 57].

Secondly, charges for internal computer services will normally take the form of a paper transfer from one department to another. The reality of such transactions is often called into question particularly if the accounting becomes at all complicated. The transfer of such notational money can also provoke extreme attitudes in managers when the management as a whole loses sight of the true object of these accounting exercises, which is to reflect responsibility [Ref. 58]. As a corollary, responsibility reflection

is diminshed if interagency transfer of funds are treated as less real than transfers of funds outside the agency.

Third, there will almost certainly be a temptation for some users to try to beat the system, a practice that should be heavily discouraged [Ref. 59] and may require redesigning or fine-tuning the control system.

Fourth, although the chargeback system effectively takes the responsibility for assessing the value of a project away from the DP organization, it still has to assess the realistic life of a project if its budget is to make sense. Such an assessment often involves political factors and can thus be difficult [Ref. 60].

Fifth, there are a number of situations that affect computer services as a whole, which are difficult to chargeout. If for instance, it is thought that the throughput of an installation can be increased by some judicious tuning, who will pay for the cost of measuring and tuning the system [Ref. 61]? From a larger perspective, who will pay the cost of a major system conversion?

Sixth, in terms of rate fluctuations, any short-term pricing strategy that allocates all costs to the user will fluctuate considerably with a negative impact on the user's ability to budget. This problem can be eased by using a longer frame ( one year, for example) for computing charge rates. Further, every change in the configuration requires a new pricing scheme, re-education of the users, and readjustment of the strategy for farming out jobs.

A final implication has to do with the capacity/price relationship where the current chargeout rate depends on the fraction of the capacity of the computer system used. As demand increases, the fraction of capacity used increases causing rates to drop; and lower rates induce increases in demand until total capacity is used. The opposite is true for a reduction in demand; reduced demand leads to less use

and a higher chargeout rate. The higher chargeout rate drives some users away, resulting in lower capacity utilization and a still higher rate. Hence, a low use-high rate spiral develops, which is precisely what the organization does not want. Therefore, central control of some computer applications could affect a better use of the computer resource, although some degree of decentralization is desirable.

With these implications as a cautionary backdrop, a simple methodological procedure for implementing a chargeback system will be proposed.

## B. OVERVIEW

William Sanders suggests a seven step process for the implementation of a chargeback system [Ref. 62]. The steps are:

1. Develop a DP department budget.
2. Decide which resources will be measured and costed.
3. Estimate maximum and anticipated use levels for each resource.
4. Decompose budget and allocate to cost pools.
5. Calculate resource use rates.
6. Select unit costing or resource method as basis for charging.
7. Develop unit rates for applications if unit costing has been selected as the charging basis.

These steps outline a straightforward approach to implementing a chargeback system and should help to simplify the implementation process. The following sections amplify these steps and include additional information which may be pertinent to their use by a NARDAC.

## C. SEVEN STEPS TO IMPLEMENTATION

### 1. Developing a Budget

Since NARDAC operates as a NIF funded activity, the object of a chargeback system is cost recovery. In order to establish prices that will allow for the recovery of costs, a budget or expenditure plan for the year must be developed so that projected costs can be identified. In small organizations, or within data processing divisions of an organization, a single budget plan would be adequate. In large organizations, however, the chargeback system can be developed more easily if separate budgets are prepared for each functional area [Ref. 63]. Within each functional area, the budget is then broken down into various cost catagories.

The NARDAC chargeback system must conform to GAO, OMB and Navy guidelines on accounting for ADP costs. GAO guidelines state that "all significant elements of cost directly related to acquiring computers and associated assets and to performing data processing functions should be collected and accounted for in ways useful for management, budgeting, and external reporting. Organizational boundries and differences in financing methods should not prevent reasonable compilation of all ADP-related expenses in cost accounts". According to GAO, the following catagories constitute full cost: [Ref. 64]

1. "Personnel. Salaries and fringe benefits for civilian and military personnel who perform and manage ADP functions; ADP-related custodial services, security, building maintenance, and contract management.
2. Equipment. Nonrecurring expenditures for acquisition and recurring cost for rental, leasing, and depreciation of computers and associated online and offline ADP equipment.
3. Computer Software. Nonrecurring expenditures for acquisition, and conversion and recurring expenses for rental, leasing, and depreciation of all types of software -- operating, multipurpose, and application.

4. Space Occupancy. Funded and unfunded costs for: (a) rental, lease, and depreciation of buildings and general office furniture; (b) building maintenance; (c) regular telephone service and utilities; and (d) custodial services and security.

5. Supplies. Expenditures for noncapital office supplies and general-purpose and special-purpose data processing materials.

6. Intra-Agency Services and Overhead. The costs of normal agency support services and overhead, either billed or allocated, and the costs of central management, policy, and procurement services.

7. Contracted Services. Any of the above services if procured contractually."

According to GAO, all direct and indirect costs associated with the operation of an ADP facility should be identified and reported. GAO stated that accounting for depreciation of ADP assets is required to obtain full reimbursement of costs and is important for management users who need to know the full cost of ADP services [Ref. 65].

OMB appears to agree with the GAO guidelines. OMB issued a draft circular in 1979, entitled "Cost Accounting, Cost Recovery and Inter-Agency Sharing of Multi-User Data Processing Facilities", to establish policies for federal agencies to account for the full cost of ADP facilities and recovery of those costs by charging the user organizations for the services provided. This circular stated that agencies would share ADP facilities and that the provider of the services shall obtain "...reimbursement for the full costs of providing services" [Ref. 66]. In an undated memorandum to the Assistant Secretary of Defense, the Assistant Secretary of the Navy stated that "... the Navy concurs generally with the concepts contained in the OMB circular."

With the above guidelines in mind, the budgetary structure for NARDAC can be formulated. Examples of functional areas that can be utilized for the budget breakdown are;

1. Production Control. Personnel, equipment, and facilities associated with the overall control and management of production.
2. Computer Processing. Personnel, equipment, and facilities associated with the actual processing of jobs (i.e., computer operators).
3. Data Entry. Personnel, equipment, and facilities associated with entry of user data into the system or translation of data to an entry medium (i.e., card punching, entering written data via terminal, etc.).
4. Technical Support. Personnel, equipment, and facilities associated with technically supporting the system (i.e., technicians, repairmen).
5. Systems and Programming. Personnel, equipment, and facilities associated with systems analysis, design, and programming.
6. Administrative Services. Personnel, equipment, and facilities associated with the administrative support of the system (i.e., secrataries, janitorial staff, etc.).

Within each of these areas the budget would then be divided into the categories outlined by GAO.

### 2. Deciding Which Resources to Measure and Cost

Developing a chargeback system is an evolutionary process in that the system originally developed will change over time as the computer system evolves and the requirements placed on the charging system change. One element that changes often is the resources that are charged for. The initial choice of chargeback resources must be made as judiciously as possible in order to reduce the changes required in the future. This, however, will never eliminate the need for future changes.

Some believe that it is best to charge for anything that can be measured. What can be measured depends on the type of measurement process, (i.e., hardware or software) and on the chargeback package selected.

Beneficial National Life Insurance Company, New York, uses JARS (Job Accounting Report System, Johnson Systems, Inc.) to charge for all resources, right down to paper. Leeds & Northrup Company, utilize Comput-A-Charge on their IBM system. The package is utilized to calculate amounts of resources used such as CPU time in seconds, lines printed, cards read and punched, tape I/O's , and disk I/O's. Charges are also computed for CRTs, modems and personnel. They utilize a separate manual system for programmers and analysts [Ref. 67]. The JABS system, (Job Analysis and Billing System) is utilized by the Naval Postgraduate School, Monterey, California. It is a highly sophisticated job accounting and reporting system for OS, VS and MVS data centers. As stated in the System Reference Library, "... it produces management, accounting and job analysis reports with both the structure and content required to meet most any users needs and provides for the allocation of data processing cost, accuratly and equitably" [Ref. 68].

Jan Snyders, in two articles written for Computer Decisions magazine, lists over 20 different chargeback software systems that are available. According to Snyders, "...this is only a sampler..." of the packages that are commercially available today [Ref. 69, 70].

Although it is not necessarily a good approach to charge for whatever can be measured, sometimes a resource is included in the chargeback scheme for no better reason.

In choosing which resources to include, it is best to ask what the result would be if the particular item were excluded. If the result of exclusion were that incorrect

prices would result and uniform allocation of cost would not be possible then it is probably best to include the resource in the chargeback system.

One of the goals of a chargeback system is to charge the users uniformly for the services provided. It is also a goal to keep the system simple enough to be understandable. Table I contains a list of resources and a suggested unit of measure for each. It is not an all-inclusive list but is intended to show a representitive sampling of what might be included in the chargeback system.

### 3. Estimating Resource Use Levels

There are basicly two methods of estimating use levels. Either anticipated actual usage or the maximum possible usage level. Estimating use levels is also a preliminary step to setting actual prices for resources. A chargeback system based on charging for use of resource units depends on the accuracy of usage predictions.

The philosophy of setting rates based on anticipated actual use is to have each of the resources fully recover costs on the basis of the amount of use it received. Significant shifts in utilization will cause a shift in cost recovery and, therefore, require an adjustment to the rate schedule to avoid charging too much or too little. It should be expected that users will be sensitive to resource utilization by others since charges caused by one user may effect charges to all users. For example, if there is excess capacity in the system, implementation of a new system would reduce the unit rates and the current users costs, since utilization would increase while costs to be recovered remains fairly fixed. However, if a user drops out, those remaining would each have to share a greater portion of the total costs.

## TABLE I

### Resources and Units of Measurement

| Resource | Unit of Measure |
|---|---|
| **Processing charges** | |
| CPU | One CPU Hour |
| Virtual Storage | 100 Kilobyte Hours |
| I/O Disk | I/O Operations (Thousands) |
| I/O Tape | I/O Operations (Thousands) |
| Spooling | 1000 Records |
| **Peripheral Devices** | |
| Tape Mounts | Per Mount |
| Card Reading | 1000 Cards |
| Card Punching | 1000 Cards |
| Printing | 1000 Lines |
| Supplies | Per Unit |
| **Time Sharing** | |
| Terminal Messages | 1000 Messages |
| Public Dial | One Hour Connect |
| **Fixed Charges** | |
| Dedicated Disk | One Million Characters (Bytes) per Month |
| Tape Storage | One Tape per Month |
| Data Entry Services | Operator Hours |
| Systems Analysis and Programming | Programmer/Analyst Hours |

Charging on the basis of maximum possible usage is another alternative. With this method, actual use levels may change, but the price is based on the theoretical

maximum usage level achievable and, therefore, remains constant. The user generally prefers this condition to the above where the prices fluctuate. The cost of excess capacity is absorbed internally when rates are set on the basis of maximum possible usage. The organization may object to these unallocated costs for excess capacity.

In order to analyze the use rates of the system, it is necessary to collect statistical data produced by the operating system. The information gathered should include data covering the resources for which the user will be charged. Measurement of actual operations, immediately prior to the institution of the chargeback system would be most usefull. From this data and historical data on system utilization (if available) the future utilization can be more accurately predicted. Analyzing trends and whatever business planning data the organization has develcped to plan for future hardware requirements can also be helpful [Ref. 71].

Depending on which method is selected, anticipated actual usage or theoretical maximum usage, the process involves either one or two steps. For anticipated actual useage, the single step above is all that is necessary. If maximum usage is selected, the second step is to determine a maximum use level for each resource. Analytically the problem is (24hrs/day x 365 days/yr) / 12 months/yr = 730 hours/month. With 730 hours per month available, one only needs to determine the production rate of the resource and divide the two to find the absolute maximum usage. For example, a printer capable of 1000 lines printed per hour could produce an absolute maximum of 730,000 lines per month. (1000 lines/hour x 730 hours/month = 730,000 lines/month) This analytical method gives an unrealistic value since factors such as maintenance, down time, paper loading, etc., are not taken into account.

A more accurate method of determining the actual maximum usage can be used. For this method it is necessary to collect current usage data. The next step is to determine what percentage of the resource capacity is being utilized. For example, if the CPU has been utilized for 300 problem program hours per month and it is estimated that the CPU has only been 70% utilized then the maximum capacity is 300 / .70 = 428.5 problem program hours per month. "The estimated percentage of maximum capacity on the CPU should be used for other hardware pools, since in most shops, use of these other rescurces is proportional to CPU use" [Ref. 72]. Hypothetical annual resource use levels are shown in Table V.

### 4. Decompose Budget and Allocate to Cost Pools

For the discussion of this step, the reader is referred to Table II and Table IV for clarification. Charges are to be made for CPU time, Tape I/O's, Disk I/O's, Print Lines, Data entry operator hours and Programmer/Analyst hours. There are nine cost pools: the six above and two overhead cost pools and the unallocated pool. Each of the Budget items in Table II is a matrix identified by its grid coordinate referenced in Table IV. Table II shows the cost pool of each budget line item. In some cases, the dollars are divided among more than one cost pool.

# TABLE II

## Cost Pool Allocations

### CPU POOL $

| | |
|---|---|
| 1B | 100,000[1] |
| 2B | 30,000[1] |
| 5B | 200,000[2] |
| 6B | 16,000[3] |
| 7B | 25,000[4] |
| | 371,000 |
| | +328,000[5] |
| | + 25,968[6] |
| | 725,168 |

### TAPE POOL $

| | |
|---|---|
| 5B | 75,000[2] |
| 6B | 6,000[3] |
| 9B | 15,000 |
| | 96,000 |
| | +54,700[5] |
| | + 4,328 |
| | 155,028 |

### DISK POOL $

| | |
|---|---|
| 5B | 150,000 |
| 6B | 12,000 |
| | 162,000 |
| | +54,700 |
| | + 4,328 |
| | 221,028 |

### PRINT POOL $

| | |
|---|---|
| 1B | 150,000[1] |
| 2B | 45,000[1] |
| 5B | 75,000[2] |
| 6B | 6,000[3] |
| 10B | 60,000 |
| | 336,000 |
| | +109,400[5] |
| | + 8,656[6] |
| | 454,056 |

### DATA ENTRY POOL $

| | |
|---|---|
| (1-13)C | 313,550 |
| | + 21,640[6] |
| | 335,190 |

### PROGRAMMER/ANALYST POOL $

| | |
|---|---|
| (1-13)A | 971,550 |
| | + 43,280[6] |
| | 1,014,830 |

### HARDWARE OVERHEAD POOL $

| | |
|---|---|
| (1-13)F | 211,000 |
| 1B | 150,000[1] |
| 2B | 45,000[1] |
| 3B | 45,000 |
| 4B | 10,000 |
| 8B | 2,000 |
| 11B | 1,000 |
| 12B | 2,000 |
| (1-13)D | + 81,000 |
| | 547,000 |
| | -547,000[5] |
| | 0 |

### GENERAL OVERHEAD POOL $

| | |
|---|---|
| (1-13)F | 108,200 |
| | -108,200[6] |
| | 0 |

### UNALLOCATED POOL $

| | |
|---|---|
| (1-13)D | 54,000 |
| (1-13)D | +171,450 |
| | 225,450 |

## TABLE III

### Final Budget Decomposition

(Summary of Table II)

| | |
|---|---|
| CPU Pool | 725,168 |
| Tape Pool | 155,028 |
| Disk Pool | 221,028 |
| Print Pool | 454,056 |
| Data Entry Pool | 335,190 |
| Programmer/Analyst Pool | 1,014,830 |
| Unallocated Pool | + 225,450 |
| Total | 3,130,750 |

Notes: (for table II )

[1] Computer operations salaries and benefits split between CPU, print, and hardware overhead pools, based on analysis of duties.

[2] Hardware expense allocated to pools based on actual equipment assigned each pool.

[3] Hardware maintenance proportionate to hardware expense.

[4] All software allocated to CPU pool.

[5] Hardware overhead allocated as follows: 60% CPU; 10% tape; 10% disk; 20% print (arbitrary).

[6] General overhead allocated as follows: 40% programmer/analyst; 20% data entry; 24% CPU; 4% tape; 4% disk; 8% print (arbitrary).

# TABLE IV

## DP Department Budget

| | A<br>Product Control<br>$ | B<br>Computer Processing<br>$ | C<br>Data Entry<br>$ | D<br>Technical Support<br>$ | E<br>Systems and Programming<br>$ | F<br>Administrative Services<br>$ | Total DP<br>$ |
|---|---|---|---|---|---|---|---|
| Salaries | 150,000 | 400,000 | 200,000 | 100,000 | 800,000 | 75,000 | 1,725,000 |
| Benefit Costs | 45,000 | 120,000 | 60,000 | 25,000 | 200,000 | 22,500 | 472,000 |
| Rent | 15,000 | 45,000 | 15,000 | 4,500 | 45,000 | 6,000 | 130,500 |
| Utilities | 0 | 10,000 | 2,000 | 0 | 0 | 0 | 12,000 |
| Hardware Rental | 0 | 500,000 | 30,000 | 0 | 25,000 | 2,500 | 557,000 |
| Hardware Maintenance | 0 | 40,000 | 2,400 | 0 | 2,000 | 200 | 44,600 |
| Software License /Rental | 0 | 25,000 | 0 | 0 | 6,000 | 0 | 31,000 |
| General Computer Supplies | 0 | 2,000 | 500 | 0 | 0 | 0 | 2,500 |
| Tape Purchases | 0 | 15,000 | 750 | 0 | 0 | 0 | 15,750 |
| Forms Cost | 0 | 60,000 | 0 | 0 | 0 | 0 | 60,000 |
| Travel | 0 | 1,000 | 0 | 5,000 | 20,000 | 0 | 26,000 |
| Office Supplies | 1,000 | 2,000 | 500 | 500 | 5,000 | 2,000 | 11,000 |
| Services Purchased Outside | 0 | 0 | 2,400 | 0 | 40,000 | 0 | 42,400 |
| Total | 211,000 | 1,220,000 | 313,550 | 135,000 | 1,143,000 | 108,200 | 3,130,750 |

### 5. Calculate Usage Rates

This is the step that calculates the rates that are to be set for each of the resources. It is a simple process of dividing the number of dollars in each cost pool (from Step 4) by the usage levels calculated for the resource (from Step 3). For the example in Table VI , annual figures were used. The rates in Table V were divided by the dollars allocated to each of the cost pools in Table IV. The calculations are shown in Table VI.

TABLE V

Resource Usage Level (Hypothetical)

| | |
|---|---|
| CPU Hours | 2,100 |
| Tape I/Os | 620 x 10 |
| Disk I/Os | 800 x 10 |
| Print Lines | 500 x 10 |
| Data Entry Hours | 35,000 |
| Programmer/ Analyst Hours | 42,000 |

### 6. Selection of Resource or Unit Costing Approach

Bills must be understandable to have a desirable effect on the user. Either the resource or unit costing approach can be utilized in determining charges as long as user understandability is not forgotten.

TABLE VI

Rate Calculations

| | | |
|---|---|---|
| CPU | $\frac{\$ 725,168}{2,100}$ | = $345.32/hr |
| Tape | $\frac{\$ 155,028}{620 \times 10}$ | = $0.25/1,000 I/Os |
| Disk | $\frac{\$ 221,028}{800 \times 10}$ | = $0.28/1,000 I/Os |
| Print | $\frac{\$ 454,056}{500 \times 10}$ | = $0.91/1,000 lines |
| Data Entry | $\frac{\$ 335,190}{35,000}$ | = $9.58/hr |
| Programmer/ Analyst | $\frac{\$1,014,830}{42,000}$ | = $24.16/hr |

The resource method entails the measurement of the amount of each resource utilized by a customer and computing the bill by multiplying the amount used by the unit cost for the resource. The user would then receive a bill such as shown in Figure 5.1.

A bill could be provided for each job or jobs could be totalled over some predefined period of time. If the users are highly knowledgeable in the computer field, this may be a satisfactory presentation. To many users, however, this type of bill is meaningless and undersirable. Many users prefer units they can measure and they can utilize to predict volume.

| Resource | Amt-Used | Rate | Cost |
|---|---|---|---|
| CPU-Time | .1525 | 345.32 per hour | 52.66 |
| Tape Input | 500 | .25 per 1000 I/Os | .43 |
| Disk Input | 5000 | .28 per 1000 I/Os | 1.40 |
| Lines Printed | 1000 | .91 per 1000 lines | .91 |
| Total | | | $ 55.19 |

Figure 5.1 Example Bill.

Charges that are based on the items produced are more usefull. For example, charges for checks printed, invoices produced, or documents produced can be easily measured and predicted by the user. This approach is known as unit costing and is described in step 7.

The third choice is to combine both resource costing and unit costing. Depending on the system, this may be the best approach. If the goals of the chargeback system are met, and the user and provider agree to the method used, any of the above methods of charging are acceptable.

### 7. Develop Unit Rate for Unit Costing

This is an optional step and only necessary if Unit Costing was chosen in Step 6. The objective of unit costing is to recover the same costs as the resource method would, but to do so by charging for items rather than resources. The bill for a particular operation would be the same, only the method of calculating it has changed. To accomplish this goal, some creative cost accounting will be needed. The following steps describe how to proceed.

### a. Deciding Which Units are to be Used

This decision requires a careful study of the application to determine what units would be meaningful, easily countable, and how the units are to be defined. In addition, the units need to have a proportionate change in unit count and resources required. For example in the trust business a workable unit is the number of accounts being serviced or processed [Ref. 73]. The amount of processing performed is dependent on the number of transactions processed. The relationship between accounts and transactions proves to be nearly constant over a stable group of accounts. There is sufficient correlation therefore, between number of accounts and resources used to utilize number of accounts as the unit of measure. The number of accounts is preferred to number of transactions since it is easier for the user to count and predict in advance.

It may be necessary to utilize more than one unit of measure to adequately express the cost in meaningful units. For example, the amount of processing may be dependent on both the number of statements produced and the transaction count. In this case, both should be used.

### b. Establish Relationship Between Number of Units and Resource Cost

This process should be accomplished over a period of several months. Table VII shows data collected utilizing a simple unit. Number of accounts was chosen for unit costing by the method described above.

### c. Calculate Unit Rate

Once the data has been obtained, the average resource cost is divided by the average number of units to arrive at a unit cost. In this example the unit cost would be calculated as follows: 18,837 / 5,634 = $ 3.34.

## TABLE VII

### Average Units and Resource Costs

| MONTH | NO. OF ACCOUNTS | RESOURCE COST $ |
|---|---|---|
| 1 | 5,625 | 18,721 |
| 2 | 5,700 | 19,085 |
| 3 | 5,683 | 18,610 |
| 4 | 5,528 | 18,302 |
| 5 | 5,632 | 19,468 |
| AVE | 5,634 | 18,837 |

d. Validation

After the unit cost is calculated, the data collected previously can be used to test the unit cost.

## TABLE VIII

### Rate Calculations Using Resource and Unit Cost

| Month | No. of Accounts | Resource Cost $ | Unit Cost (@$3.34) | % Difference |
|---|---|---|---|---|
| 1 | 5,625 | 18,721 | 18,788 | +0.36 |
| 2 | 5,700 | 19,085 | 19,038 | -0.25 |
| 3 | 5,638 | 18,610 | 18,981 | +1.99 |
| 4 | 5,528 | 18,302 | 18,463 | +0.88 |
| 5 | 5,632 | 19,468 | 18,811 | -3.37 |
|  |  | ------ | ------ | ----- |
|  |  | 94,186 | 94,081 | -0.11 |

These calculations are shown in Table VIII. The example shows excellent results but this precision can not always be expected. If the results showed significant variation, the unit cost could be adjusted, either up or down, as required to correct the problem.

## D. SUMMARY

The above procedure lends itself well to the proposed NARDAC chargeback algorithm. Under the Navy's NARDAC charging algorithm all ADP costs incurred at the NARDAC are distributed to ten resource pools -- nine hardware systems and one labor pool. Users of the resource pools are charged their proportional share of these costs through the billing algorithm. As an example of how the hardware and labor pool breakdown occurs, NARDAC San Diego has the following resource pools utilized:

1. U-1100
2. B-4700
3. IBM-360
4. U-1500
5. OCR
6. Xerox
7. EAM
8. Data Entry
9. Microfiche
10. Labor

The resource pool utilization measurement vehicle is equipment dependent. For example, the third generation systems (U-1100 or B-4700) have automatic logs maintained by the host operating system which automaticaly keep customer application of such integral parts of the computer system as CPU time, memory time, input/output time, terminal connect time, temporary disk used, cards read and punched, pages

printed, etc. Conversely, other systems (U-1500, EAM, Xerox) which process a single job at a time, have utilization measured in either wall clock time or units of production. System usage for these units is recorded manually. The labor pool is measured in direct labor hours. Individual rates are established for each measureable component of the various resource pools to allow for cost recovery from each customer based on their ADP applications.*

Although charging for computer services is a complicated and iterative process, the seven step procedure addressed above should provide a baseline for implementation of a chargeback procedure. Concurrently, the process will satisfy the previously addressed chargeback standards in an effective and efficient manner.

---

*NARDAC ADP Chargeback Procedures Manual obtained from NARDAC San Diego.

# VI. CONCLUSIONS

This thesis has addressed the Navy decision to implement a chargeback system for computer services provided by the Naval Regional Data Automation Command (NARDAC) as a result of the recent decision to convert NARDACs to the NIF funding concept. A review of the chargeback concept, its relationship to the organizational control structure, the economic implications of chargeback, and the impact of the NIF funding concept were presented and evaluated. Finally, a simplified approach to implementing a chargeback system was presented and discussed.

From the above discussions, it appears that the Navy's decision to convert NARDACs to NIF funding was fortuitous and provides an excellent opportunity to realize improvements in the effectiveness and efficiency with which they operate.

The rapid growth in data processing activities experienced over the past several decades should be expected to continue into the indefinite future. This growth will continue to stress the resources of any given computer center. In such an environment, a comprehensive control system which integrates and formalizes the planning process, project management process, the chargeback system, and consolidates computing activities under tight budgetary controls is required if future budgetary growth is to be controlled without any major loss to an accepted level of service. The NIF funding decision and its related chargeback technique are vital elements of this control system and cannot, therefore, be viewed in isolation.

It appears obvious that as data processing consumes a greater proportional share of the organizational budget, the imposition of controls and the expectation that the computer center will operate under rigorous time, cost, supply and demand considerations will become the norm. Gone are the days when the tremendous expenses associated with DP operations can be simply written off as overhead. Data processing will have to compete for resources in a hard nose way and show an economic analysis with a tangible "profit". They will have to demonstrate that it is more economical to perform these operations in-house than to buy them from the outside and be able to demonstrate that they are operating in a managerially sophisticated manner. Whether the policy is for the center to operate under a cost or pricing philosophy is a top management determination dictated by the organization's perception of its goals. In either approach, the computer center is going to have to charge for its services. Thus, although the transformation to the NIF funding and chargeback environment will not be without its obstacles, and although it will not necessarily restrict DP budgetary growth, it does provide a medium to realize improved management practices, provides an opportunity to redefine the control system in such a manner that they foster the attainment of organizational objectives, and provides a mechanism for increased cost control and resource allocation. In short, it provides a means to improve the ability of management to make sound economic decisions.

Whether or not this conversion process realizes its potential benefits will be affected by a host of factors. These include the sophistication with which the control system and performance measures are implemented, the degree of organizational support this process is accorded both within NAVDAC and by the major claimants, and by the ability of the organization to send out proper accountability signals in a rate stabilization environment.

There is nothing new about charging for computer services. It has been widely and successfully used in the corporate world for over a decade. Thus, arguments that the chargeback system should be abandoned as an unworkable idea should be ignored as specious and self-serving. There will be a multiplicity of problems associated with this conversion, and there will be increased recognition of DP costs by the major claimants which will generate strong demands for the NARDACs to operate in a more efficient manner, to cut overhead costs, to expand its number of customers, and improve the timeliness of its output. But from an organizational perspective these pressures should beget positive improvements. It is the authors' strong impression that chargeback is vital if the organization is to realize the maximum benefits for its data processing dollar. It is the most widely accepted method for an organization to properly allocate its resources among often conflicting requirements and, simultaenously, attain a satisfactory level of cost control.

# LIST OF REFERENCES

1. Parish, R. J., *The Navy Industrial Fund and its Applicability to the Naval Data Automation Command*, M.S. Thesis, Naval Postgraduate School, Monterey, California, p. 13, 1980.

2. Dearden, J. and Nolan, R. L., "How to Control the Computer Resource," *Harvard Business Review*, p. 68-78, November-December 1973.

3. Rizzuto, C. and Rizzuto, R., "Chargeouts: A Perspective for Change," *Datamation*, p. 125-128, December 1978.

4. *Data Processing Management*, "DP user Chargeback," Auerback Publishers, Inc., p. 2-02-03/04, Revised 1983.

5. "Taking Control of Computer Spending," *Business Week*, p. 50, 12 July 1982.

6. "The Effects of Chargeback Policies," *EDP Analyzer*, Vol. 11, No. 11, p. 1-14, November 1973.

7. Stoner, James A.F., *Management*, Prentice-Hall Inc., Englewood Cliffs, N.J., p. 606, 1982.

8. Dearden, John and Nolan, Richard L., "How to Control the Computer Resource," *Harvard Business Review*, November-December 1973, p. 68-78.

9. Dearden, John and Nolan, Richard L., "How to Control the Computer Resource," *Harvard Business Review*, November-December 1973, p. 68-78.

10. Cash, James I., Jr., McFarland, Warren F., and McKenney, James L., *Corporate Information Systems Management: Text and Cases*, Richard D. Irwin, Inc., Homewood, Illinois, 1983, p. 255-259.

11. Cash, James I., Jr., McFarland, Warren F., and McKenney, James L., *Corporate Information Systems Management: Text and Cases*, Richard D. Irwin, Inc., Homewood, Illinois, 1983, p. 259-260.

12. Porter, W. Thomas and Perry, William E., *EDP Controls and Auditing*, Wadsworth Publishing Company, Inc., Belmont, California, 1977, p. 2.

13. Horgren, Charles T., *Accounting for Mangaement Control: An Introduction*, Prentice Hall, Inc., Englewood Cliffs, N.J., 1965, p. 147.

14. Cash, James I., Jr., McFarland, F. Warren, and McKenney, James L., *Corporate Information Systems Management: Text and Cases*, Richard D. Irwin, Inc., Homewood, Illinois, 1983, p. 269-270.

15. Horngren, Charles T., *Accounting for Management Control: An Introduction*, Prentice Hall, Inc., Englewood Cliffs, N.J., 1965, p. 292.

16. Ibid., p. 295.

17. Cushing, B.E., "Pricing Internal Computer Services : The Basic Issues," *Management Accounting*, p. 47-50, April 1976.

18. *Data Processing Management*, "DP User Chargeback," Auberback Publishers, Inc., p. 5-6, Revised 1983.

19. McKell, L.J., Hansen, J.V., and Lester E. Heitger, "Charging for Computer Services," *Computing Surveys*, p. 105-120, June 1979.

20. Drury, D.H., "Conditions Affecting Chargeback Effectiveness," *Information and Management*, Vol. 5, No. 1, p. 31, March 1982.

21. Ibid., p. 31.

22. Ibid.

23. Ibid.

24. "The Effects of Chargeback Policies," *EDP Analyzer*, Vol. 11, No. 11, p. 9, November 1973.

25. Ibid.

26. "Guidelines for Cost Accounting Practices for Data Processing," *Database* (*A Quarterly Newsletter of SIGDP*), Vol. 8, No. 3, p. 3, Winter 1977 Supplement.

27. Ibid.

28. Ibid.

29. *Data Processing Management*, "DP User Chargeback," Auerback Publishers, Inc., p. 1-2, Revised 1983.

30. Ibid., p. 3-4.

31. Butler, D., "Chargeback for Information Systems: Breakthrough or Fad," *Computing Economics (International Computer State of the Art Report 12)*, Infotech, Information Limited, p. 449-458, 1973.

32. McKell, L.J., Hansen, J.V., and Heitger, L.E., "Charging for Computer Services," *Computing Surveys*, p. 115, June 1979.

33. Nolan, R.L., "Effects of Chargeout on User/Manager Attitudes," *Communications of the ACM*, p. 177-185, March 1977.

34. Schmidt, S., "Flexible Pricing of Computer Services," *Management Science*, p. B-581/B-600, June 1968.

35. Sutherland, I.E., " A Futures Market in Computer Time," *Communications of the ACM*, p. 449-451, June 1968.

36. Nielsen, N. R., " The Allocation of Computer Resources -- is Pricing the Answer?" *Communications of the ACM*, p. 468-474, August 1970.

37. Ibid., p. 470.

38. Sharpe, W.F., *The Economics of Computers*, Columbia University Press, 1969.

39. Schwab, B., "The Economics of Sharing Computers," *Harvard Business Review*, Vol. 46, No. 5, p. 61-70, 1968.

40. Streeter, D.N., "Cost-Benefit Evaluation of Scientific Computing," *IBM Systems Journal*, Vol. 11, No. 3, p. 219-233, 1972.

41. Streeter, D.N., "Centralization or Dispersion of Computing Policies," *IBM Systems Journal*, Vol. 12, No. 3, p. 283-301, 1973.

42. Borovits, I., and Newmann, S., "Internal Pricing for Computer Services," *The Computer Journal*, p. 199-204, August 1978.

43. "Navy Industrial Fund Module (Unit 1)," *Practical Comptrollership Course*, Text, Naval Postgraduate School, Monterey, California, p. 13, Revised 1981-1982.

44. "Navy Industrial Fund Module H," *Practical Comptrollership Course*, Text, Naval Postgraduate School, Monterey, California, p. H-5, Revised 1983.

45. "Navy Industrial Fund Module H," *Practical Comptrollership Course*, Text, Naval Plstgraduate School, Monterey, California, p. H-3, Revised 1981-1982.

46. Ibid., p. H-6.

47. Parish, R.J., *The Navy Industrial Fund and its Applicability to the Navy Data Automation Command*, M.S. Thesis, Naval Postgraduate School, Monterey, California, p. 23, 1980.

48. Ibid.

49. Ibid., p. 26.

50. "Navy Industrial Fund Module H," *Practical Comptrollership Course*, Text, Naval Postgraduate School, Monterey, California, p. H-19, Revised 1983.

51. Ibid.

52. Ibid., p. H-22.

53. Ibid., p. H-8.

54. Ibid., p. H-8/9.

55. Ibid., p. H-13 through H-15.

56. Ibid., p. H-16/17.

57. Butler, D., "Chargeback for Information Systems: Breakthrough or Fad," *Computing Economics (International Computer State of the Art Report 12)*, Infotech, Information Limited, p. 141-142.

58. Ibid., p. 147.

59. Ibid., p. 148.

60. Ibid., p. 139.

61. Ibid., p. 140-141.

62. *Data Processing Management*, "DP User Chargeback," Auerback Publishers, Inc., p. 8, Revised 1983.

63. Ibid.

64. *Illustrative Accounting Procedures for Federal Agencies*, U.S. General Accounting Office, Accounting Pamphlet No. 4, 1978.

65. Ibid.

66. U.S. Naval Data Automation Command, *ADP Chargeback Operating Procedures Manual*, 1978.

67. Snyders, J., "Chargeback Software," *Computer Decisions*, Vol. 13, No. 2, February 1981.

68. Duquesne Systems Inc., *Job Analysis and Billing System (JAB)*, *Systems Reference Library*, 2 February 1981.

69. Snyders, J., "Chargeback Software," *Computer Decisions*, Vol. 13, No. 2, February 1981.

70. Snyders, J., "Chargeback Systems Offer Big Benefits," *Computer Decisions*, Vol 14, No. 9, September 1982.

71. *Data Processing Management*, "DP User Chargeback," Auerback Publishing, Inc., p. 10, Revised 1983.

72. Ibid., p. 4.

73. Ibid., p. 14.

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